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**SUMMER 73  
ÉTÉ 73**

Despite his normal appearance, this curious little fellow has a rather unique background. The result of an ovum transplant, he has two mothers. See story page 3.

Malgré son apparence normale, ce petit veau curieux est un gaillard dont l'origine est assez unique. Produit de la transplantation d'une ovule, il a eu deux mères. Voir article page 3.

# CANADA AGRICULTURE



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*General view of surgery in progress.*

# EMBRYO TRANSFER IN CATTLE

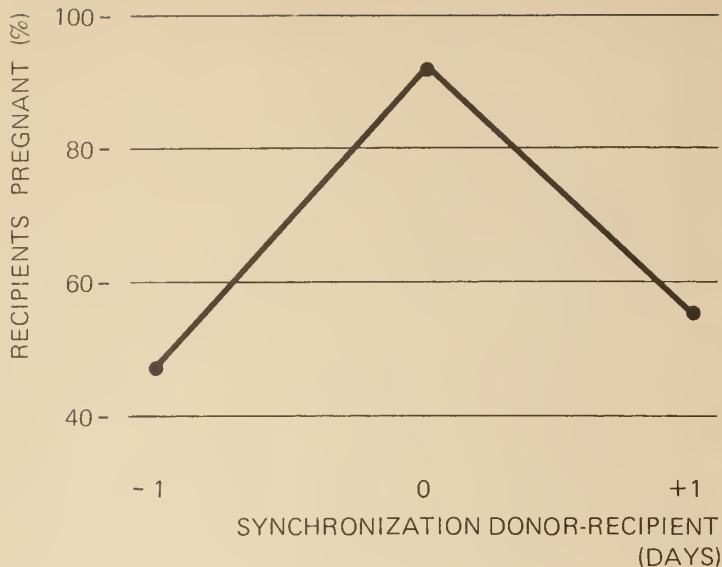
D. MITCHELL and K.J. BETTERIDGE

Bien que la technique de transplantation de l'ovule, soit employée expérimentalement depuis 1890, ce n'est qu'avec les progrès récents dans l'élevage des moutons, des porcs et des bovins que l'application commerciale en a été rendue possible. La technique, qui comprend actuellement une superovulation suivie d'une opération chirurgicale importante pour transplanter chaque ovule fécondé dans l'utérus des receveurs non apparentés, permet aux éleveurs d'accroître la descendance d'une femelle de qualité génétique supérieure. Bien qu'il existe actuellement des restrictions d'ordre pratique, la transplantation d'ovule offre des possibilités plus grandes encore que l'insémination artificielle, une fois les problèmes actuels résolus.

In 1890, Walter Heape, in Cambridge, England, reported the transfer of two-day-old fertilized eggs (or ova) from a female rabbit of one breed to another female rabbit of a different breed. The latter, designated the recipient, subsequently gave birth to normal young bearing the breed characteristics of the female that provided the eggs, designated the donor. Since this historic experiment, scientists in many parts of the world have utilized this basic technique of embryo or ovum transfer in numerous laboratory and domestic animal species to further knowledge, particularly in genetics, reproductive physiology and embryology. The bulk of this research has been carried out during the past 20 years during which time there has been increasing interest in the use of the technique to improve farm animal production. Significant advances have been made in sheep, pigs and cattle, to the point where commercial application has become a practical possibility. Much of this developmental work, especially in cattle has also been done in Cambridge, by Rowson and his colleagues.

Dr. Mitchell is head of Theriogenology and Dr. Betteridge is head of Physiology at the CDA Animal Diseases Research Institute, Hull, Que.



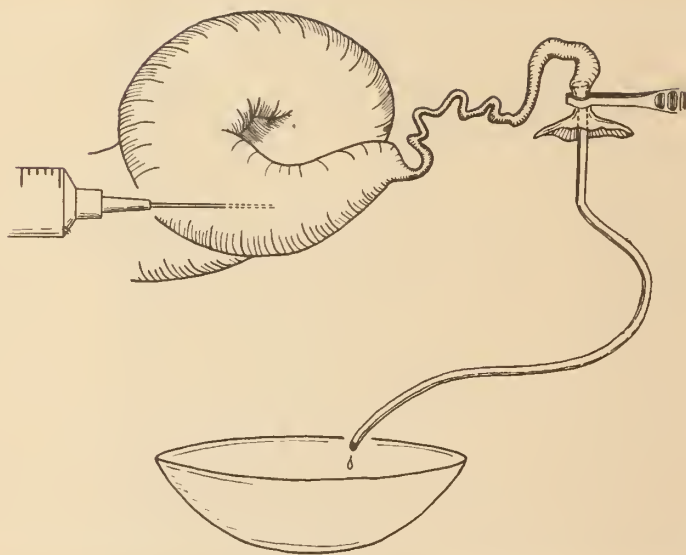


*Effect of difference in heat synchronization between donor and recipient on percentage of pregnancies obtained with transferred embryos (adapted from Rowson).*



*Technician picking up embryos from collecting dish using dissecting microscope and fine pipette.*

*Method of flushing embryos from uterus. Needle inserted in tip of uterine horn, cannula held in ovarian end of Fallopian tube.*



## INTRODUCTION

A relatively small number of female cattle possess superior genetic qualities with respect to milk or meat production. Normally such individuals will produce on the average, no more than 6-8 calves during their lifetime. The majority of the other breeding females in the national herd are unlikely to contribute improved production potential to their progeny unless they have been mated to a superior male.

Upgrading of progeny is thus presently dependent on the use of: selected matings; test programs; cross-breeding; and artificial insemination. None of these methods can however, alter the contribution of the dam to the genetic make-up of the resulting calf whereas embryo transfer permits selection of both sire and dam. It is apparent that if in some way the superior females can be made to produce large numbers of embryos in a short period of time and the inferior animals can be used to develop and carry these embryos through pregnancy, a major contribution will have been made to speed up the selection and production of animals for improved dairy and/or beef qualities. This objective can be achieved by using the valuable animals as donors for embryo transfer after treating them with hormones to produce large numbers of ova at one time. These ova are fertilized by mating to a selected superior sire, then collected and transferred a few days after fertilization, to the required number of recipients.

Since 1969, at the Animal Diseases Research Institute, Hull, Quebec, we have been exploring the technical problems of embryo transfer in cattle and, to a lesser extent, in pigs. Because of the considerable interest in its commercial application to Canadian



*Embryo being injected from collecting pipette into uterus of recipient.*

cattle and because there are still problems in achieving consistent, reliable results, this article will review our experience and knowledge.

### **THE EMBRYO TRANSFER TECHNIQUE**

The basic sequence of events required to carry out embryo transfers is:

- 1 Close synchronization of heat (estrus) between donor and recipient.
- 2 Hormonal treatment of the donor to induce the shedding of a large number of ova—this is termed “superovulation”.
- 3 Collection of embryos from the donor 5-10 days after she has been mated.
- 4 Microscopic identification and storage of the embryos until time of transfer.
- 5 Transfer of embryos, singly or in pairs to the required number of recipients.

*Problems* Natural estrus synchronization was used for early work on embryo transfer in cattle but this required maintaining a large herd of potential recipients to ensure that an adequate number were in heat on the same day as the donor. Recently it has been found that one of a group of naturally occurring substances called prostaglandins when injected into an animal between the fourth and sixteenth day of a normal heat cycle will cause that animal to have a normal heat three days later. This product has now been synthesized and should soon become available for field use, thus eliminating one of the unpredictable elements of embryo transfer.

Unfortunately, the response to a standard superovulation treatment varies widely between individuals and this is still a major obstacle to routine application of the technique. In our experience, a single

treatment may produce from zero to over forty eggs.

At present, major surgery is required to achieve high pregnancy rates in recipients. This not only increases the cost but also limits the number of times the same donor can be used. We have repeated such operations up to three times, but the inevitable development of tissue adhesions around the uterus and ovaries limits the number of successful collections that can be anticipated. Preliminary studies on non-surgical collection and transfer suggest that it may be possible to develop these for practical application in the future.

Until recently, it was not possible to store embryos in a viable state for more than a few days outside the cow. However, the establishment of a pregnancy with an embryo stored frozen at  $-169^{\circ}\text{C}$  at Cambridge, suggests that freezing will be the method which will provide a major breakthrough in the commercial use of embryo transfer.

*Results* Because of the problems encountered, mainly with superovulation and estrus synchronization, we have found that of all experiments planned with a single donor and recipient, only 50 percent were completed, i.e. resulted in production and transfer of fertilized ova. Once we had established our techniques we have been able to achieve over 70 percent pregnancies from completed transfers. Workers in Cambridge using much larger numbers have found that they can obtain about 80 percent pregnancies from completed transfers. The fact that the latter figure is at least 10 percent higher than that achieved by first service artificial insemination is explained by the fact that only normal fertilized ova are used. In artificial insemination, both fertilization failure and abnormal development of the early em-





*Normal 5 day-old fertilized egg magnified  $\times 625$  times. Cleavage has proceeded to 16 cell stage.*

bryo combine to lower the number of pregnancies established. All calves born to date have been normal and healthy, although it must be remembered that these calves can inherit any genetic abnormality present in the true parents. Their parentage can be confirmed by blood typing.

### POTENTIAL APPLICATIONS

There is some concern that premature exploitation of this technique without a complete understanding of the problems involved may affect its commercial acceptance. However, provided its present limitations are appreciated and that these are surmounted as a result of future research, it may be predicted that embryo transfer will prove of value not only in research but in one or more of the following aspects of livestock production:

- 1 Increased production of offspring from selected individuals of superior genetic merit in order to increase meat and/or milk production,
- 2 Increased calf production by twin transfers, especially in beef breeds using inferior recipients,
- 3 International import/export trade, particularly to introduce new breeds or blood-lines,
- 4 Repopulation of herds after epidemic diseases such as foot and mouth disease, where a slaughter policy is imposed and,
- 5 Salvage of genetic material where the superior donor cow can produce fertilized eggs, but cannot produce live calves.

### CONCLUSIONS

Embryo transfer has proved an extremely useful research tool and, as indicated, under defined condi-



*A Holstein "foster mother" is shown with her twin Angus-cross calves, the result of an embryo transplant.*

tions a high percentage of fertilized ova can be expected to develop into live calves in the uterus of unrelated recipients. However, because of problems such as failure of fertilization, estrus synchronization and superovulation, the degree of wastage amongst all animals committed is still high. Therefore, the decision to submit a valuable animal to this operation must be a calculated risk.

Despite significant recent advances in methods of embryo storage and estrus synchronization, further research is required on these aspects. In addition, consistent, predictable and repeatable methods of superovulation have still not been developed. The major surgical procedures and the facilities which they require not only mean high capital costs but also limit the number of ovum-collection operations one can carry out on individual animals. It is obvious too that reliable non-surgical techniques of collection and introduction of the embryo into the recipient, which are presently under investigation, must be developed before ovum transfer can become as routine as artificial insemination.

Although a number of commercial embryo transfers have been successfully completed by groups operating in Canada and England, the establishment of economical scientifically based units which will provide a significant contribution to the livestock industry requires careful planning and continuous reassessment in relation to the latest research discoveries. It has the potential to become an even more valuable asset than artificial insemination but this potential can only be attained if solutions to existing problems are discovered. It is to be hoped that the present commercial interest is not premature and that future progress in this field will be marked by successful scientific innovation and not by exploitation. ■

# PLANT GROWTH— THE RESPONSE TO AN EVER- CHANGING ENVIRONMENT

# CROISSANCE DES PLANTES— RÉACTION À UN MILIEU ÉVOLUTIF

## R. L. DESJARDINS

The response of a crop to its environment is complex, the net result being the interaction of many recognized but imperfectly understood factors. For example, even under irrigated conditions and identical management practices, corn yields have been found to vary from 112 to 176 bushels per acre in a five year trial. Such variations are common for most economic crops. They may be due to many environmental factors but are primarily due to climatic differences. Only by measuring plant growth on a shorter time basis can one hope to understand and possibly allow for these factors.

At the Agrometeorology Section of the Plant Research Institute, we have observed short-term fluctuations of environmental elements. The importance of a knowledge of the distribution of short-term fluctuations in interpreting some of these values will be discussed. We will also present measurements of CO<sub>2</sub> uptake obtained at one point one meter above a corn crop. Such measurements could be very useful, because we believe that agricultural experiments which often take many years to obtain conclusive results, i.e. to determine whether one variety or treatment is significantly superior to another, could be shortened considerably by comparing such measurements for each treatment throughout a growing season.

Dr. Desjardins is the micrometeorologist at the CDA Plant Research Institute, Ottawa.

## R. L. DESJARDINS

La réaction d'une culture à son milieu est complexe, et a pour résultat net une interaction de nombreux facteurs admis mais mal connus. Par exemple, un essai de culture de maïs en irrigation et selon des techniques culturales identiques, d'une durée de 5 ans, a donné des rendements allant de 112 à 176 boisseaux à l'acre. De telles variations sont courantes dans la plupart des cultures d'importance économique. Elles peuvent provenir de nombreux facteurs écologiques, mais surtout de variations climatiques. Ce n'est qu'en mesurant le développement des plantes sur des périodes plus courtes que l'on pourra espérer comprendre et tenir compte de ces facteurs.

A la Section d'agrométéorologie de l'Institut de recherches sur les végétaux, nous avons observé des fluctuations à court terme de facteurs écologiques. Nous traiterons de l'importance de connaître la distribution des fluctuations à court terme pour l'interprétation de ces valeurs. Nous présenterons aussi des données sur l'absorption de CO<sub>2</sub>, mesurée à 1 mètre au-dessus d'une culture de maïs. Ces mesures pourraient être très utiles, car nous croyons que les expériences agronomiques, qui exigent souvent de nombreuses années pour donner des résultats concluants, c'est-à-dire pour déterminer si une variété ou un traitement est significativement supérieur à un autre, pourraient être considérablement raccourcies en comparant de telles mesures faites sur chaque traitement pendant toute la saison de développement.

Il se produit en plein champ, sur de courtes périodes, de fortes fluctuations de température, d'humidité, d'éclairement, de concentration en CO<sub>2</sub> et de vent. La température ambiante et l'humidité spécifique peuvent par exemple s'écarter de 20% de leur valeur moyenne en quelques secondes, tandis que le

M. Desjardins est micrométéorologue à la Section d'agrométéorologie de l'Institut de recherches sur les végétaux d'Agriculture Canada.



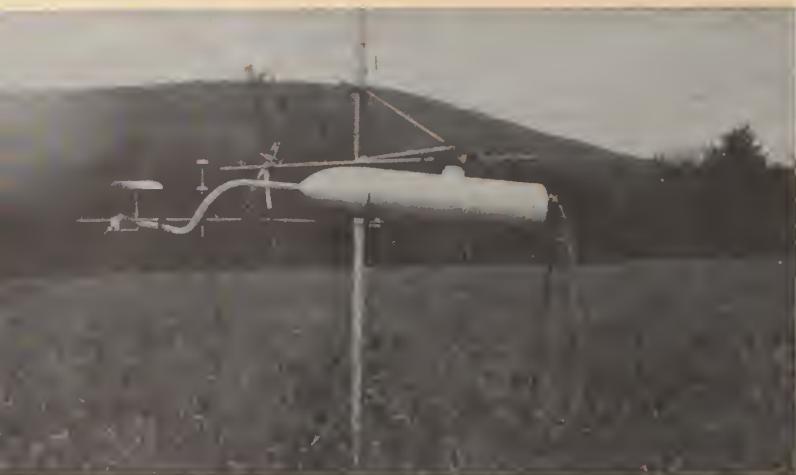
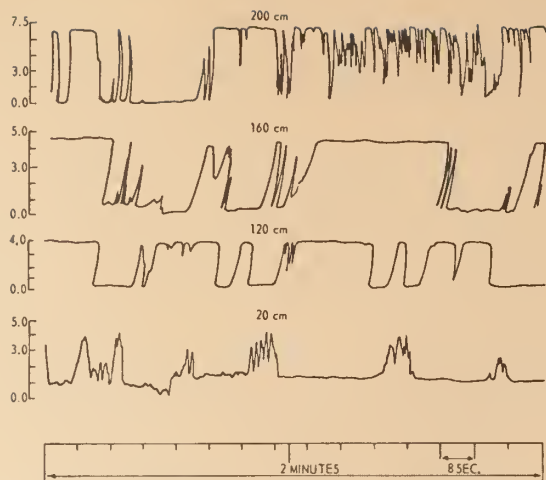


Figure 1 (Top left) Relative measurements of simultaneous fluctuations of photosynthetically active radiation around noon at various heights above ground level within a fully grown corn crop 260 cm high.

Figure 2 (Top right) Simultaneous measurements of  $CO_2$  concentration,  $c$ , vertical wind,  $w$ , horizontal wind,  $u$ , and air temperature,  $T$ , at one meter above a corn crop.

Figure 3 (Bottom left) An infrared carbon dioxide analyzer and wind sensors used to measure the short-term growth of a corn crop.

Figure 4 (Bottom right) Carbon dioxide uptake in pounds of  $CO_2$  per hour measured at one meter above a corn crop during normal (July 24) and dry conditions (August 24). July 24 was sunny with cloudy intervals, while August 24 was sunny but hazy.

Marked short period fluctuations in temperature, humidity, light conditions,  $CO_2$  concentration, and wind occur in the field. For example, air temperature and the specific humidity may fluctuate by up to 20% of their mean values within a few seconds while radiation and wind can also change by an order of magnitude within a few seconds.

Fluctuations of radiation measured simultaneously at four heights in a corn crop with four identical fast responding traversing sensors revealed that leaves are either exposed to sunflecks or to shade spots (Figure 1). Hence, a mean light quantity, even though it is commonly used, is a quantity which rarely exists in

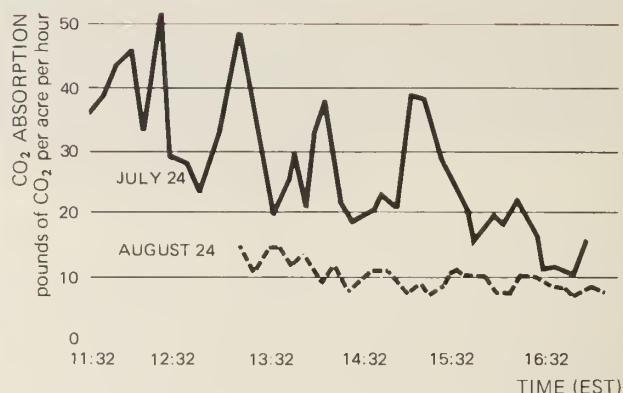
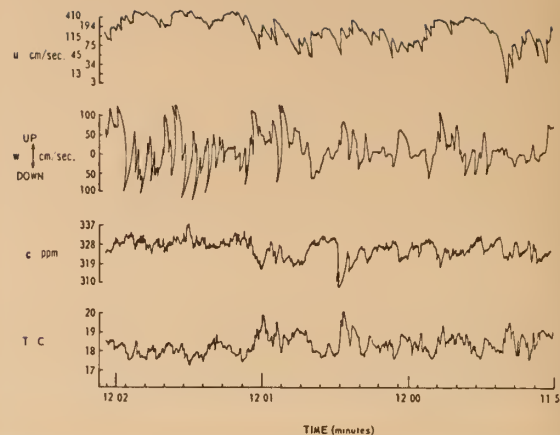


Figure 1 (en haut à gauche) Mesure relative des variations simultanées du rayonnement photosynthétiquement actif, vers midi, à diverses hauteurs au-dessus du sol, dans une culture mature de maïs de 260 cm de hauteur.

Figure 2 (en haut à droite) Mesure simultanée de la concentration en  $CO_2$  ( $c$ ), du vent vertical ( $w$ ), du vent horizontal ( $u$ ) et de la température ambiante ( $T$ ) à un mètre au-dessus d'une culture de maïs.

Figure 3 (en bas à gauche) Doseur à l'infrarouge de  $CO_2$  et capteurs de vent, employés pour mesurer la croissance d'une culture de maïs sur de courtes périodes.

Figure 4 (en bas à droite) Absorption de gaz carbonique, en livres de  $CO_2$  à l'heure, mesurée à un mètre au-dessus d'une culture de maïs dans des conditions normales (24 juillet) et de sécheresse (24 août). Le 24 juillet, le temps était ensoleillé avec périodes nuageuses, tandis que le 24 août, il était ensoleillé mais brumeux.

rayonnement et la vitesse du vent peuvent décupler aussi en quelques secondes.

Les variations du rayonnement, mesuré simultanément à quatre hauteurs dans un champ de maïs au moyen de quatre radiomètres mobiles identiques, à mesure rapide, ont montré que les feuilles sont soit exposées à des points de lumière, soit à l'abri de points d'ombre (figure 1). Ainsi, le rayonnement moyen, couramment employé, est une quantité que l'on conçoit difficilement dans la pratique. De fait, on a estimé que du fait de la réaction non linéaire des plantes à la lumière, l'emploi d'une valeur moyenne de rayonnement plutôt que la distribution réelle du rayonnement



a crop. Actually, it has been estimated that due to the non-linear response of plants to light, the use of a mean radiation value rather than the actual distribution of radiation can cause an over-estimation of 20 to 40 percent in net photosynthesis. Although fluctuations of most environmental elements are not as large, abnormal distributions also exist and should be taken into account in crop-weather models.

Simultaneous short-term fluctuations of horizontal (u) and vertical (w) wind, CO<sub>2</sub> concentration (c) and air temperature (T) recorded at one meter above an actively growing corn crop demonstrate the complexity of the interrelationships between temperature, CO<sub>2</sub> and vertical and horizontal wind fluctuations (Figure 2). On some of these occasions, parcels of air moving upward from inside the crop were warmer by up to 2°C and their CO<sub>2</sub> concentration were decreased by as much as 18 ppm. A fairly constant CO<sub>2</sub> concentration and temperature was associated with most downdrafts.

Data of this type recorded with instruments shown in Figure 3 has been used to measure the carbon dioxide uptake of crops under field conditions for periods as short as ten minutes with an accuracy of a couple of pounds of CO<sub>2</sub> per acre per hour. Such measurements are presented for two daytime periods one month apart for a corn crop with 30,000 plants per acre (Figure 4). The large variations in CO<sub>2</sub> uptake on July 24th were very closely related to the fluctuations in radiation and the large reduction on August 24 was expected because of the extremely dry soil conditions.

CO<sub>2</sub> uptake is a realistic measure of plant growth because 43% of a plant's dry weight is due to the carbon which comes mainly from the CO<sub>2</sub> in the air. Hence, for a plant to increase in weight by two thousandths of a pound, which is approximately 1/5 of the maximum a corn plant can increase in one day, it must absorb approximately three thousandths of a pound of CO<sub>2</sub>.

Such measurements should be extremely useful in determining some of the reasons for yearly yield differences and also evaluating management practices which are extremely difficult to evaluate when using end-of-year yields which are confounded by complex annual climatic variations. They should also help us understand the basic plant mechanisms which should permit the development of reasonable crop-weather models. This is very important because the great number of possible combinations of field experiments, particularly in the area of microclimatic modification, make it practically impossible to come up with the optimum conditions simply by using a trial and error approach. Environmental manipulation in models is much faster and easier than doing the actual field tests, but there are still numerous gaps in our knowledge of crop response to the micro-environment to be completely satisfied with the presently available crop-weather models. ■

peut conduire à une surestimation de 20 à 40% de la photosynthèse nette. Même si les variations de la plupart des facteurs écologiques ne sont pas aussi grandes, il existe aussi des distributions anormales dont il faut tenir compte dans les modèles culture-temps.

Les variations simultanées à court terme du vent horizontal (u) et vertical (w), de la concentration en CO<sub>2</sub> (c) et de la température ambiante (T), enregistrées à un mètre au-dessus d'une culture de maïs en pleine croissance ont démontré la complexité des corrélations entre ces fluctuations (figure 2). Dans certains cas, des masses d'air s'élevant de l'intérieur de la culture étaient plus chaudes de 2°C, et leur concentration en CO<sub>2</sub> était abaissée de 18 ppm. La plupart du temps, aux courants descendants correspondaient des concentrations en CO<sub>2</sub> et des températures assez constantes.

Des données de ce genre, recueillies au moyen d'instruments présentés à la figure 3 ont servi à mesurer l'absorption de gaz carbonique de cultures de plein champ pendant de courtes périodes de 10 minutes avec une précision d'environ 2 livres de CO<sub>2</sub> à l'acre à l'heure. La figure 4 donne les résultats ainsi obtenus au cours de deux périodes diurnes choisies à un mois d'intervalle dans une culture de maïs d'une densité de 30,000 plants à l'acre. Les fortes variations de l'absorption de CO<sub>2</sub> le 24 juillet étaient très étroitement liées aux variations du rayonnement, et l'importante baisse de l'absorption le 24 août était prévisible, à cause de la grande sécheresse du sol.

L'absorption de CO<sub>2</sub> est une mesure réaliste de la croissance, car 43% du poids sec des plantes sont constitués de carbone, qui provient surtout du CO<sub>2</sub> de l'air. Ainsi, pour qu'une plante augmente son poids de deux millièmes de livre, soit environ le cinquième de ce qu'un plant de maïs peut gagner en un jour, elle doit absorber environ trois millièmes de livre de CO<sub>2</sub>.

De telles mesures seraient extrêmement utiles pour déterminer quelques-unes des raisons pour lesquelles le rendement varie d'une année à l'autre, et aussi pour évaluer les techniques culturales, difficiles à évaluer au moyen des rendements annuels, et perturbées par des variations climatiques annuelles complexes. Elles nous permettraient aussi de comprendre les mécanismes fondamentaux des plantes, conduisant ainsi à l'élaboration de modèles culture-temps acceptables. Cela est très important, car le grand nombre de combinaisons possibles d'expériences au champ, particulièrement dans le domaine des variations microclimatiques, fait qu'il est pratiquement impossible de déterminer les conditions optimales par une approche d'expérimentation et d'erreur. L'expérimentation écologique sur modèles est beaucoup plus rapide et aisée que ne le sont les expériences en plein champ, mais notre connaissance de la réaction des plantes au microclimat est trop imparfaite pour que nous soyons entièrement satisfaits des modèles culture-temps actuels. ■

# SUNDANCE— A HARD RED WINTER WHEAT



*Dr. Grant examines Sundance winter wheat grown on dryland at Lethbridge, Alta. The crop yielded 51 bushels per acre.*

## M. N. GRANT

En vue d'obtenir une variété dont le rendement serait supérieur à celui de Winalta sans que sa résistance à l'hiver ne soit pour autant diminuée, les chercheurs à Lethbridge ont créé et homologué la nouvelle variété Sundance de blé roux d'hiver vitreux. Cette variété s'adapte bien aux régions du sud de l'Alberta et du sud-ouest de la Saskatchewan qui produisent habituellement du blé d'hiver, mais sa faible résistance à la rouille des feuilles et de la tige empêche sa production dans les régions plus à l'Est.

Sundance, a new variety of hard red winter wheat licensed in 1971, was developed at the CDA Research Station at Lethbridge. It originated from the cross Cheyenne x Kharkov 22 MC. The line, designated as 5520-8 and later named Sundance, was selected from a population consisting of 3,000 progeny rows in 1960. The objective of the program was to develop a higher yielding variety than Winalta without any loss in winterhardiness.

Winter wheat has been grown for almost seventy years in southern Alberta. Production has been limited, however, to about 200,000 acres, primarily because of the hazards associated with winterkilling outside the favorable influence of the Chinook winds. In the areas where winter wheat production is feasible, farmers tend to devote a portion of their land to this crop. They appreciate the way this practice spreads their work and machinery load over a wide

Dr. Grant is a cereal breeder at the CDA Research Station, Lethbridge, Alta.

time range, and also the control they obtain over winter soil erosion. Because winter wheat develops earlier and makes more efficient use of June rains than spring wheat, it usually outyields spring wheat.

Over the years farmers progressed from old varieties like Turkey Red to Kharkov 22 MC, Jones Fife, and Yogo. A big advance in bread-making quality was achieved with the release of Winalta in 1961. An effort to improve on the yielding ability of Winalta met with success in the licensing of the new variety, Sundance.

In 17 tests conducted over a 5-year period, Sundance averaged 19 per cent higher in yield than Winalta. In winterhardiness, it is at least equal and probably superior to Winalta. Agronomically, Sundance resembles Kharkov 22 MC more than it does Winalta. It is similar to Kharkov 22 MC in days to maturity, straw length, and straw strength. However, it is much superior to Kharkov 22 MC in resistance to shattering. As the plants approach maturity the leaves of Sundance tend to remain green longer than those of Kharkov 22 MC or Winalta.

About 700 bushels of Sundance Select Seed were distributed to seed growers in Alberta and Saskatchewan in 1972. The performance of Sundance under farm practice confirmed the superior yielding ability shown earlier in small-plot trials. Approximately 40,000 bushels of pedigreed seed were produced in 1972.

Sundance appears to be well adapted to the traditional winter wheat producing areas of southern Alberta and southwestern Saskatchewan. Its susceptibility to leaf and stem rust precludes its production in eastern Saskatchewan or Manitoba. Tests now in progress will determine its acceptability in parts of the United States. ■





# WINTER WHEAT

## IN NORTHERN MANITOBA AND SASKATCHEWAN

E. D. SPRATT

Depuis que certaines variétés vivaces de blé d'hiver sont disponibles, des cultivateurs des régions du nord du Manitoba et du Saskatchewan profitent des avantages de ces variétés pour réduire leur travail et mettre à profit les conditions climatiques. D'excellentes récoltes ont été obtenues en cultivant le blé sur chaume. Des essais indiquent qu'une couverture de neige sans interruption est nécessaire pour réduire les effets du gel. Les cultivateurs doivent aussi tenir compte de la résistance à la rouille lors du choix de leurs semences de blé d'hiver. Bien que les superficies soient encore petites dans ces régions septentrionales, la demande de grains de provendes entrainera probablement un intérêt accru pour cette culture.

At the present time, winter wheat is grown only on a very small acreage in NW Manitoba. This acreage will likely be expanded however, when the market for utility (feed) wheat is developed. Farmers appreciate the advantage of being able to harvest winter wheat before other crops, thus improving their chances of missing the poor harvest weather which often occurs by mid-September, especially at The Pas.

Two factors favor winter wheat production in the parkland region of NW Manitoba and NE Saskatchewan. The crop usually escapes serious stem rust infections, and snow cover is usually adequate to protect the crop from exposure in winter.

Hardy varieties are available for growing in northern Manitoba and Saskatchewan. Table 1 shows comparative performance of winter wheat varieties at The Pas and Swan River since 1966. Sundance, a newly licensed Canadian variety, appears to be as winter hardy as Kharkov 22. It is similar to Kharkov in many agronomic characteristics and has better grain quality. Winalta, widely grown in southern Alberta, yields about 15 percent less than the Russian varieties in NW Manitoba.

Excellent yields of winter wheat have been obtained at Swan River when grown on stubble. Winter killing, resulting in low yields has been a problem in early work with winter wheat on summerfallow at The Pas, largely because snow cover was poor.

At the CDA Research Station, Swift Current, M.H. Anderson has shown that winter killing is closely related to snow cover. The practice of seeding winter wheat into stubble to trap the snow has been successful in minimizing winter kill.

Seeding winter wheat into stubble at Brandon has  
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NOTE LEAST SIGNIFICANT DIFFERENCE  
FOR FERTILIZERS = 1490 LB/ACRE  
FOR VARIETIES = 590 LB/ACRE.

Figure 1 The effect of fertilizer nitrogen on yields of Sundance winter wheat, Glenlea spring wheat, Bonanza barley and Harmon oats grown at Swan River, Manitoba in 1972.

Figure 2 Total dry matter production and grain yields of Kharkov winter wheat, Neepawa spring wheat and Fergus barley grown at Brandon, Manitoba in 1970.

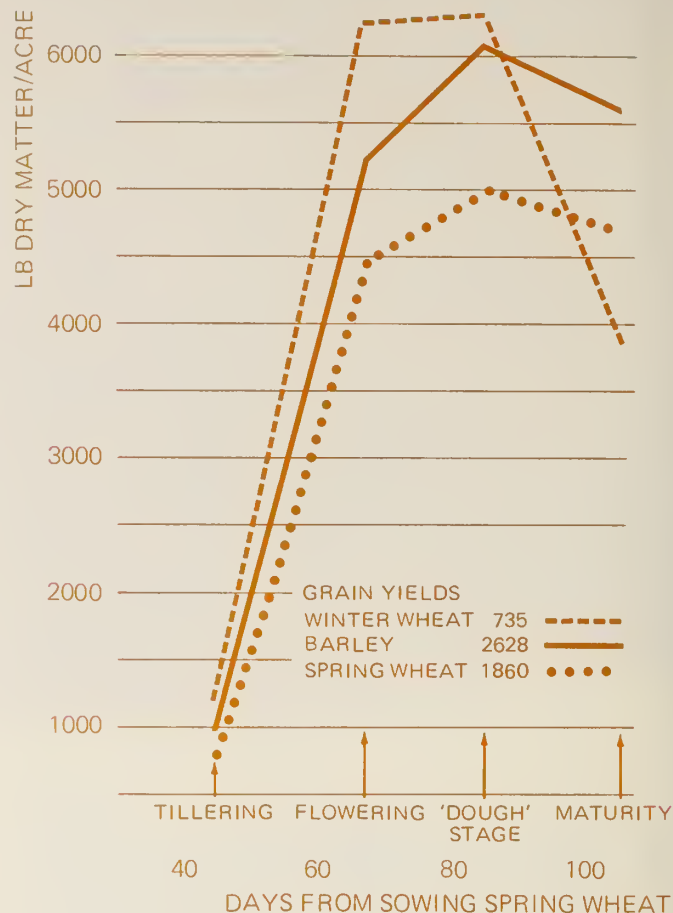


TABLE 1 YIELD OF WINTER WHEAT VARIETIES (LB/ACRE OF GRAIN) GROWN AT THE PAS AND SWAN RIVER, 1966-72

	The Pas <sup>1</sup>				Swan River <sup>2</sup>	
	1966	1967	1969	1970	1971	1972
Kharkov 22	3300	3240	3360	2700	2820	4640
Uljanovka	3120	3780	3720	2760	2940	4200
Alabaskaja	2820	3780	3300	2640	2880	4360
Winalta	2880	1980	2160	2280	2520	3770
Sundance				3060	—	4620

<sup>1</sup>Grown on summerfallow without fertilizer. 1968 failure due to lack of snow cover and winter killing.

<sup>2</sup>Grown in standing stubble with fertilizer (40 lb P<sub>2</sub>O<sub>5</sub> and 100 lb N/acre).

TABLE 2 YIELDS OF KHARKOV WINTER WHEAT (LB/ACRE OF GRAIN) GROWN AT SWAN RIVER IN 1970-71 AND 1971-72, AS AFFECTED BY NITROGEN AND PHOSPHATE FERTILIZER.

	lb P O /acre (applied at seeding)	lb N /acre (applied in the spring)		
		0	50	100
a. 1971	0	1080	2100	2400
	45	1080	2820	3300
	90	1380	3180	3720
	LSD=450			
b. 1972	0	3910	5060	4870
	45	3950	5150	5450
	90	4610	4740	4970
	LSD=890			

also reduced winter killing. However, stem rust in the area results in poor grain yields.

Winter wheat responds well to fertilizer (Table 2). Optimum yields were obtained with applications of 45 lb P<sub>2</sub>O<sub>5</sub>/acre with the seed in the fall and 50 lb of extra nitrogen per acre in the spring. The crop responded better to this treatment in 1972 than 1971.

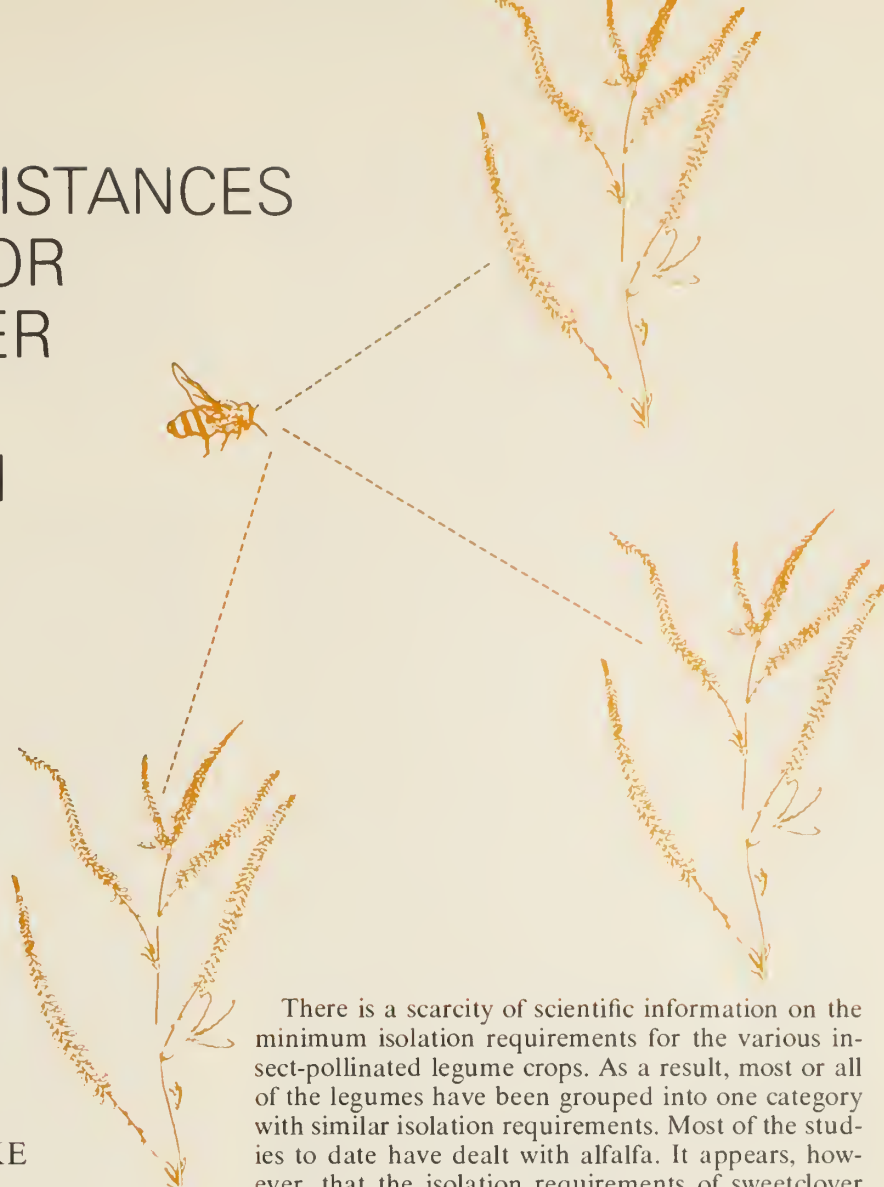
In 1972, in another test, (Figure 1) the yields of Sundance winter wheat exceeded the yields of Glenlea spring wheat, and compared favorably with oats and barley varieties. Winter wheat and oats responded efficiently to the highest rate of nitrogen. This test was grown near a shelterbelt and on a very fertile clay loam soil that had been in hay, and had received heavy manure applications.

In a comparative test at Brandon in 1971 (Figure 2), winter wheat appeared to be the best crop throughout the growing season but stem rust decreased the grain yields drastically. Silage yields were comparable to spring wheat and barley.

Research on the development of new winter wheat varieties for the prairies will be continued by Dr. W.N. Grant at CDA Research Station, Lethbridge and Dr. Fowler of the new Crop Development Centre, University of Saskatchewan. Tests conducted by the Brandon Research Station show that winter wheat has a great potential in areas where snow cover is maintained throughout the winter. But rust resistance must be bred into existing varieties to increase their area of adaptation. ■



# ISOLATION DISTANCES REQUIRED FOR SWEETCLOVER SEED PRODUCTION



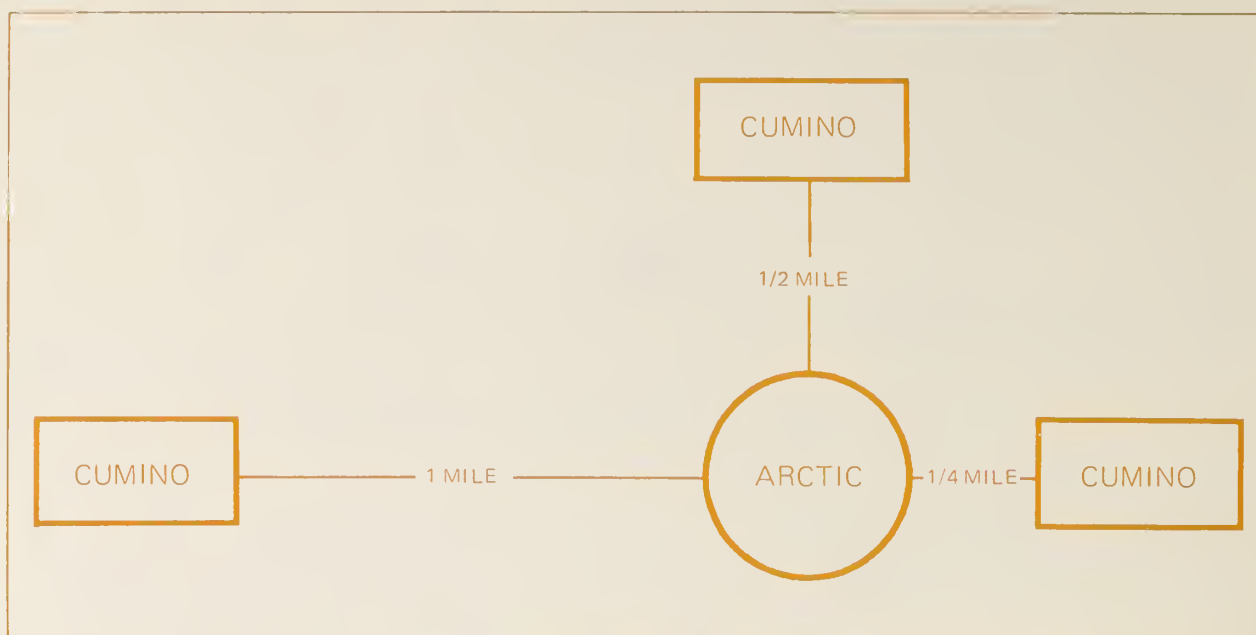
B. P. GOPLEN, D. A. COOKE  
and P. PANKIW

Les recherches indiquent que les exigences d'isolement minimums pour les diverses légumineuses pollinisées par des insectes peuvent varier considérablement, et que ces distances doivent être déterminées si l'on veut maintenir la pureté génétique dans les multiplications des semences des diverses cultures. L'emploi d'abeilles domestiques comme agents de pollinisation et du gène à faible teneur de coumarine comme marqueur génétique récessif a permis de constater un taux élevé de contamination résultant du croisement du mélilot pour des distances d'isolement de 50 verges et même d'un demi-mille, quand il y avait peu de fleurs concurrentes à proximité. L'utilisation d'une culture fortement attrayante pour les abeilles (par exemple le colza) peut servir de barrière d'isolement très efficace. Les résultats des recherches indiquent qu'on devrait penser sérieusement à remettre à jour les normes d'isolement pour la production des semences de mélilot.

There is a scarcity of scientific information on the minimum isolation requirements for the various insect-pollinated legume crops. As a result, most or all of the legumes have been grouped into one category with similar isolation requirements. Most of the studies to date have dealt with alfalfa. It appears, however, that the isolation requirements of sweetclover may be much higher than alfalfa because of the high attractiveness of sweetclover to the honey bee. Hence a series of field experiments were carried out to determine minimal isolation requirements and yet maintain genetic purity in seed increases of sweetclover. The low coumarin gene *cu* was used as a recessive genetic marker in three separate tests designed to study the effects of isolation distance on contamination levels from outcrossing.

For each test, seed was collected from the low coumarin (LC) isolation plots and the seeds germinated and grown in the greenhouse for four weeks. Each seedling was then classified as high or low coumarin, based on a fluorometric chemical assay. High coumarin seedlings were the result of outcrossing from pollen of the contaminant (HC) source plot. Honey bees were used as pollinators. The general plan of these experiments was to seed a central plot of sweetclover which provided the contaminating high coumarin source of pollen. Radiating from this central plot were low coumarin marker plots

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*Experimental design of a typical test on determining minimum isolation distance.*

seeded at various distances from the contaminant source. Following cross pollination and seed set, each of the low coumarin marker plots were assessed for relative degree of contamination by outcrossing.

In spite of considerable variability in results from the three separate experiments, several interesting observations were made. Typical results are shown in the table. The main conclusion reached was that a high amount of contamination from crossing may occur in sweetclover with isolation distances from 50 yards and even up to  $\frac{1}{2}$  mile when there is little competitive bloom. There was a high degree of contamination from outcrossing particularly in the case of the minimum 50-yard isolation distance.

### COMPETITIVE CROPS

A significant observation was the lack of contamination from crossing when the sweetclover plots were surrounded by rape. Even with a minimum 50-yard isolation strip of rapeseed, little or no contam-

ination resulted in the sweetclover marker plot. It is widely recognized that sweetclover and rapeseed are both highly attractive to honey bees for a source of nectar and pollen. Thus a highly competitive crop such as rapeseed may serve as a very effective isolation barrier in the production of pedigreed legume crops pollinated by insects. Further research is needed to test this theory.

Present isolation requirements in Canada and the United States may be inadequate to maintain a high level of purity in sweetclover. In successive generations of increase of the low coumarin variety Cumino, it was found that the contamination levels increased as follows:

Breeder .27% → Foundation 1.11% → Registered 4.21% → Certified 19.80%. Similar results were recorded for low coumarin Denta increased in the United States:

Breeder 0.71% → Foundation 1.69% → Certified 3.62%.

These results are especially important since both of these studies were based on samples drawn from growers' seed lots and produced under existing isolation requirements.

The data from the above experiments are sufficient to seriously question existing isolation standards for sweetclover, even though they are not adequate to formulate new standards. However, it would appear highly desirable to increase isolation requirements for sweetclover, particularly of the Foundation class. ■

CONTAMINATION OF SWEETCLOVER PLOTS WITH ISOLATION DISTANCES OF 0, 50, 200, AND 300 YARDS

Isolation distance (yd)	% contamination
0	4.89
50	5.87
200	1.15
300	.65



P. PARCHOMCHUK  
and A.D. McMECHAN

Il nous faut de meilleurs convoyeurs pour les récolteuses mécaniques de fruits. Quatre différents convoyeurs ont été conçus et évalués à Summerland. L'objectif est d'obtenir un remplissage uniforme avec un minimum de dommages.

The increased mechanization of deciduous fruit harvesting has created a need for efficient bulk bin fillers for use on field equipment. The ideal binfiller should be easily transportable on field equipment, should be capable of handling a large volume of fruit in a short time, should distribute the fruit uniformly in the bin and, most important, should not cause any further damage to the fruit. Several commercial apple harvesters incorporate bin filling devices but little attention is given to avoid fruit damage, probably because damage caused by the mechanical harvester itself is quite high. The binfillers used in packing houses are not suitable for use on mobile field equipment.

At the CDA Research Station, Summerland, B.C., we have constructed and evaluated four different

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types of binfillers to meet the requirements of various harvesting procedures and machinery. These are described below.

#### ARCHED CONVEYOR FILLER

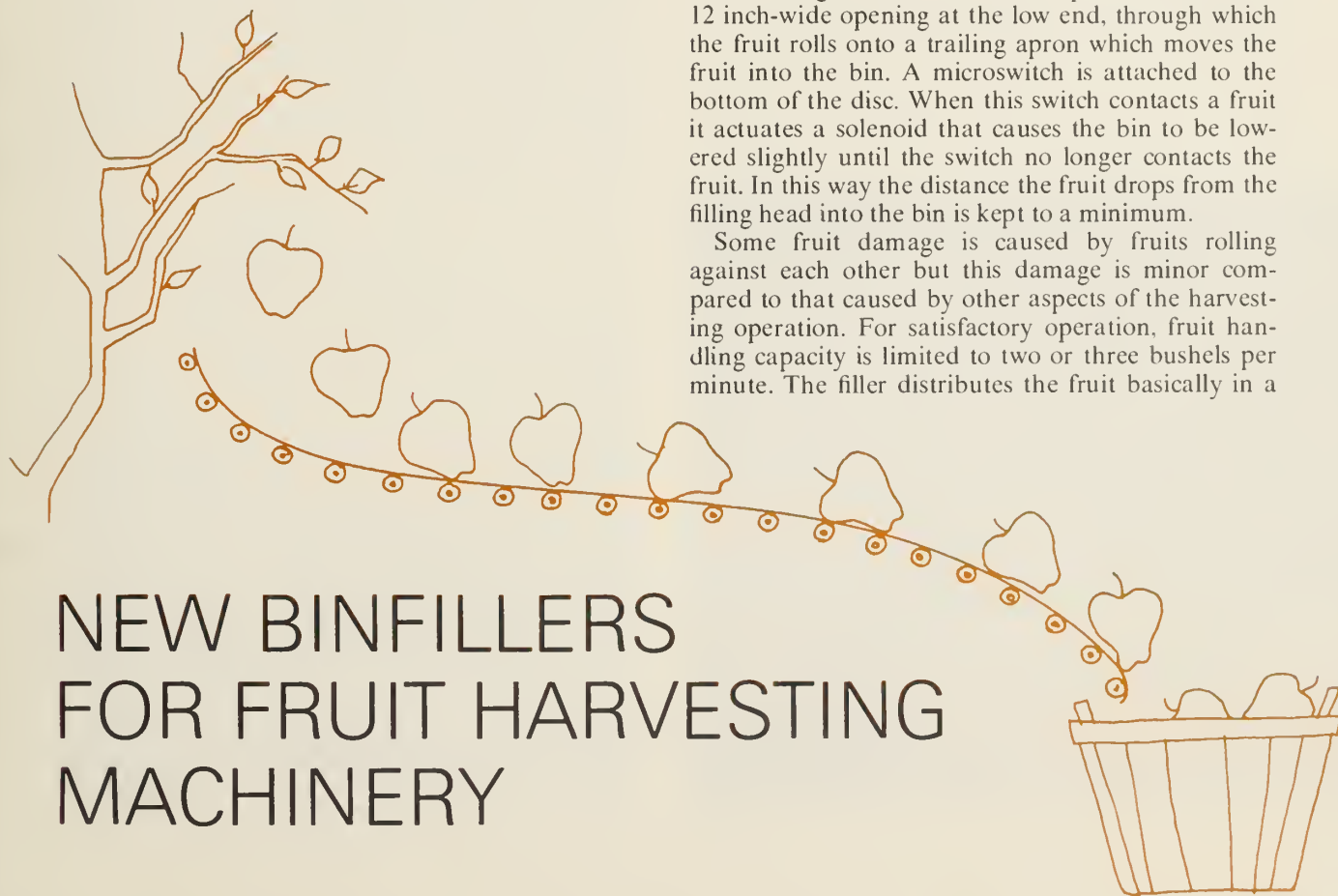
A binfiller designed for use on a tomato picking aid carries the fruit into the bin on an arched conveyor. This conveyor consists of an endless belt of vinyl-coated nylon fabric draped over rods ten inches apart to form a series of cupped troughs the same width as the bin. The cupped troughs carry the fruit and empty it into the bin at the end of the conveyor. The machine operator moves the bin back and forth under the conveyor to get uniform distribution of the tomatoes. The end of the conveyor is kept just above the level of the fruit in the bin.

This binfiller caused little damage in harvesting trials and easily handled the output of six pickers. Fruit distribution in the bin was generally satisfactory but if the machine was operated on a side slope the fruit tended to crowd to the lower side.

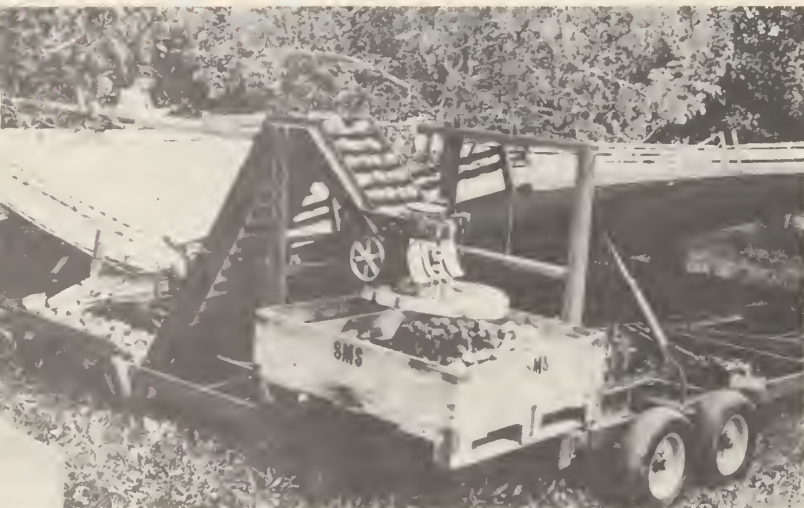
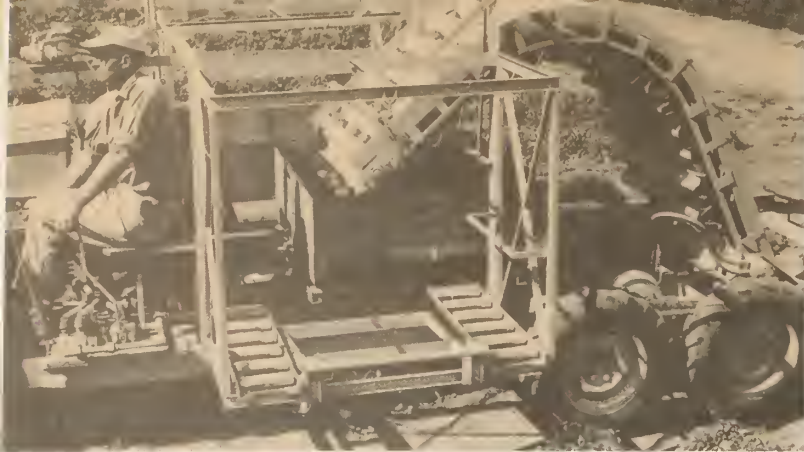
#### ROTATING HEAD FILLER

In a second bin filling device, developed for handling mechanically harvested apples, the fruit is carried down into the bin on a 15 inch-wide cleated conveyor belt and transferred to a rotating filling head. This filling head is a sloping, padded, dish-shaped disc rotating at three revolutions per minute with a 12 inch-wide opening at the low end, through which the fruit rolls onto a trailing apron which moves the fruit into the bin. A microswitch is attached to the bottom of the disc. When this switch contacts a fruit it actuates a solenoid that causes the bin to be lowered slightly until the switch no longer contacts the fruit. In this way the distance the fruit drops from the filling head into the bin is kept to a minimum.

Some fruit damage is caused by fruits rolling against each other but this damage is minor compared to that caused by other aspects of the harvesting operation. For satisfactory operation, fruit handling capacity is limited to two or three bushels per minute. The filler distributes the fruit basically in a



## NEW BINFILLERS FOR FRUIT HARVESTING MACHINERY



(Top) The arched conveyor binfiller was designed for use on a tomato picking aid.

(Bottom) Developed for handling mechanically harvested apples, the rotating head filler has proven to be satisfactory in field trials.

The trap door binfiller was developed for use in conjunction with a picking aid for fresh apples.



circular 12 inch-wide band. Fruits have to roll a short distance to get under the filling head and into the corners of the bin. As with the tomato binfiller, a sloping terrain interferes with fruit distribution.

### RECIPROCATING PANEL FILLER

To obtain a higher handling capacity and decrease potential for damaging the fruit, we designed a new type of filler in 1972. This filler lowers the fruit into the bin between two pairs of 35 inch-wide padded panels. One panel of each pair is fixed; the other reciprocates at 250 cpm, varying the gap between panels from two to four inches, and intermittently trapping and releasing the falling fruit. The fruit drops about four inches each time it is released. Distribution over the length of the bin is accomplished by moving the assembly back and forth on an overhead track at 20 cpm. Four microswitches on the bottom of the filling head sense the fruit level and cause the bin to be lowered slightly whenever one of them contacts a fruit.

The reciprocating panel filler causes less fruit damage than the rotating head. As with the rotating head, filling is most uniform when both the bin and filling mechanism are kept level. One advantage of the reciprocating head is that it places fruit right into the corners of the bin.

### TRAPDOOR FILLER

The fourth binfiller which we developed is used in conjunction with a picking aid for fresh market apples. The filling head is a 39 inch-square padded box six inches deep. The bottom of the box consists of six hinged flaps, six inches wide and 38 inches long, much like trapdoors. The filling head is rotated about its center as fruit is fed onto it from a conveyor. When the box is full the conveyor is stopped, the box is lowered into the bin and the trapdoors are opened to discharge the apples. The filler is then raised above the bin, the trapdoors are closed and the conveyor again feeds fruit into the filler. The operation is repeated six times to fill the bin. The emptying operation takes only 20 seconds. During this time apples picked by the crew are accumulated on the stationary conveyor.

Very little damage is caused by this method. The fruit distribution is uniform and is not affected by ground slope. Because the conveyor must be stopped when the filling head is lowered into the bin, this method will be restricted to applications where stopping the fruit flow for short periods of time presents no disadvantage.

Design of a good binfiller for use with mechanical fruit harvesting equipment presents many problems. It is obvious that no one design will be suitable for all situations. Each of the four fillers described here has been designed to meet a particular need. While the designs proved fairly satisfactory we feel there is still plenty of scope for improvement. ■



J. M. McARTHUR

Par suite des études de pâturage, les chercheurs de Summerland ont constaté que les légumineuses météorisantes contiennent des mousants protéiques solubles qui occasionnent la météorisation chez les ruminants. En outre, ils ont découvert que certaines légumineuses contiennent du tanin qui précipite les protéines responsables de la météorisation, ce qui rend ces légumineuses non météorisantes.

At the CDA Research Station, Summerland, B.C. we have been studying pasture bloat in cattle. It has been estimated that this disorder is responsible for over fifty percent of the deaths in cattle and even greater economic losses in productivity.

There are curative treatments for bloat but these require frequent inspection of the animals and when bloat occurs, it requires quick and sometimes drastic treatment. In dairy cattle, even with successful treatment, there is a decrease in milk production. Consequently, at Summerland we have favored preventive methods over curative ones.

Ruminant animals bloat when they cannot get rid of the microbial fermentation gases produced in their rumen. The result is that as the gas pressure builds up the rumen becomes distended and if the pressure continues to increase, the animal soon dies. In pasture bloat, the fermentation gases are trapped in a foam which develops in the rumen. The usual treatment is to administer an agent that will break the foam. This treatment is not always successful and to save the animal it may be necessary to make an incision in the flank to release the gas and foam.

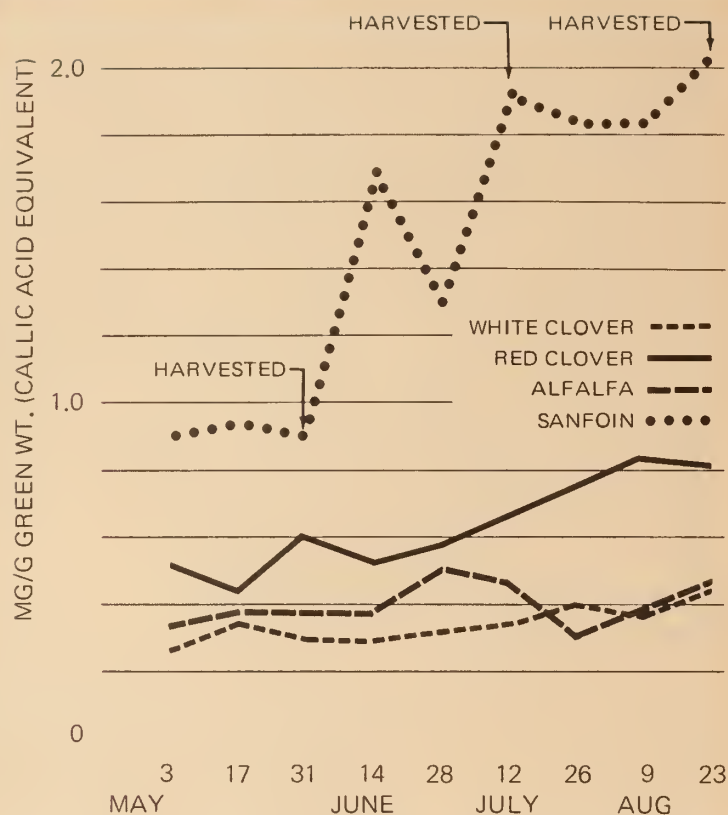
### BLOATING PROPERTIES

The bloating properties of legumes such as alfalfa and some of the clovers are well known. However, sainfoin (*Onobrychis sativa*) is a nutritious legume and as far as we know does not cause bloat. Therefore we decided to study this legume to find out why cattle feeding on it do not bloat. In addition, we hope that we might gain information that would help us develop other nonbloating forages. In our investigations we found that bloating legumes such as alfalfa and some clovers had a high soluble protein content whereas the nonbloating legume, sainfoin, was very low. This was surprising because the total protein content of both types of legumes were comparable. This suggested that some constituent in sainfoin was reacting with the soluble proteins when the plant was crushed. Tannins are common constituents in the plant kingdom and have the property

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# SOME DIFFERENCES BETWEEN BLOATING AND NONBLOATING LEGUME FORAGES





Seasonal variation in tannin content of various forages.

of precipitating proteins. However this reaction can be prevented by PVP (polyvinyl pyrrolidone). When the soluble proteins were extracted in the presence of PVP the recovery from sainfoin was equal to that from alfalfa and clover. Thus it appears that sainfoin is nonbloating because it contains tannins that precipitate bloat-producing proteins.

## TEST RESULTS

In a further experiment, sainfoin, alfalfa and red and white clovers were analyzed for tannin content throughout a growing season. It was found that the tannin content of sainfoin was much greater than the bloating forages as shown in the graph.

These results led us to examine other legumes for tannin content. Those that are known to produce bloat (eg. alfalfa and some clovers) do not contain tannins. However trefoil, crown vetch, sericea and Korean lespedezas, which are nonbloating, all contain appreciable quantities of tannins. The tannin content of birdsfoot trefoil varieties varied from zero in varieties such as Leo and Empire, to fairly high levels in Cascade. However the varieties that did not contain tannins were low in protein. In this plant it appears that two factors may be involved in its nonbloating character; low protein and/or high tannin content.

## SOLUBLE PROTEIN AND TANNINS IN SOME LEGUMES

Forage	Soluble protein % dry weight	% Soluble protein precipitated by tannins
Alfalfa ( <i>Medicago sativa</i> )	11	0
Clovers		
Alsike ( <i>Trifolium hybridum</i> )	10	0
Berseem ( <i>T. alexandrinum</i> )	7	0
Crimson ( <i>T. incarnatum</i> )	7	0
Kura ( <i>T. ambiguum</i> )	11	0
Large hop ( <i>T. campestre</i> )	7	80
Persian ( <i>T. resupinatum</i> )	11	0
Rabbit foot ( <i>T. arvense</i> )	10	90
Red ( <i>T. pratense</i> )	13	0
Small hop ( <i>T. dubium</i> )	7	0
Strawberry ( <i>T. fragiferum</i> )	9	0
Sub ( <i>T. subterraneum</i> )	11	0
White ( <i>T. repens</i> )	12	0
Lespedezas		
Korean ( <i>Lespedeza stipulacea</i> )	9	55
Sericea ( <i>L. cuneata</i> )		
High tannin selection	9	93
Low tannin selection	9	23
White lupine ( <i>Lupinus albus</i> )	13	0
Sainfoin ( <i>Onobrychis viciaefolia</i> )	12	90
Trefoils		
Big ( <i>Lotus pendunculatus</i> )	9	90
Birdsfoot ( <i>L. corniculatus</i> )	8	0-60
Narrow leaf ( <i>L. tenuis</i> )	9	10
Vetches		
Cicer ( <i>Astrolagus cicer</i> )	10	0
Crown ( <i>Coronilla varia</i> )	10	0-90
Hairy ( <i>Vicia villosa</i> )	11	0

Subclover has been rated by some as nonbloating but we have been reliably informed that bloat has been observed on subclover in Australia. Two interesting plants, high in tannin content, are large hop clover and rabbit foot clover. Unfortunately we have no information on their bloating properties.

From our investigations it appears that none of the bloating legumes contain protein-precipitating tannins whereas some of the nonbloating legumes contain appreciable amounts. This is not to say that nonbloating legumes do not cause bloat because they contain tannins. There are probably other factors involved in nonbloating forages, for example low protein content. It has been suggested that subclover may have a low bloat potential because it is tough and the plant contents are not readily released. However our results do indicate that if tannins could be introduced genetically into our bloating forages we may produce nonbloating strains.

Some high tannin plants such as crown vetch and lespedezas, appear to be less palatable to cattle because of their tannin content. On the other hand, some high tannin plants such as sainfoins and trefoils do not appear to have this disadvantage. This suggests that there are different types of tannins involved so we may have to develop plants for both tannin content and type. ■



# CROP AND SOIL STUDIES THROUGH PHOTOGRAPHIC REMOTE SENSING

H.R. JACKSON and V.R. WALLEN

La photographie en fausses couleurs s'est avérée très utile pour l'échantillonnage par avion de l'état des cultures, des forêts et des caractéristiques du sol. Cette technique, en effet, permet de voir "en couleurs", des longueurs d'ondes normalement invisibles à l'œil nu. En comparant les intensités des photographies, on peut déterminer avec plus d'exactitude les pertes des cultures. Le rehaussement de l'image en fausses couleurs permet l'analyse par ordinateur. Jusqu'à présent, la photographie en fausses couleurs a été essayée pour un certain nombre de cultures afin d'y déceler les maladies, les infestations par les insectes, l'étendue de dommages causés par l'hiver, les dégâts causés par l'eau et pour des études sur le drainage. Cette technique de télédétection permet l'élaboration d'une méthodologie, puisque les premiers symptômes d'une situation peuvent souvent être détectés avant qu'ils ne soient visibles sur les lieux.

All solar energy is transmitted, absorbed or reflected by the earth's atmosphere, surface and vegetation. The behavior of its radiation is dependent on the peculiarities of the material with which it comes in contact and, when recorded or "sensed" by photographic or electro-mechanical instruments, the characteristics of different types of vegetation, soil and water produce spectral signatures. Sensing in a number of wavebands in the ultraviolet, visible and in-

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*Two low oblique aerial photographs taken simultaneously in May of pasture fields on clayey soils east of Ottawa. Upper, photographed with conventional color film shows natural color while the lower photograph, using infrared false color film, reproduces areas of healthy vegetation as bright red or magenta while areas of bare soil or last year's stubble appears blue or cyan. Comparing the left side of each photograph, the color contrast of plant growth and of soil with relatively higher surface moisture is more obvious.*

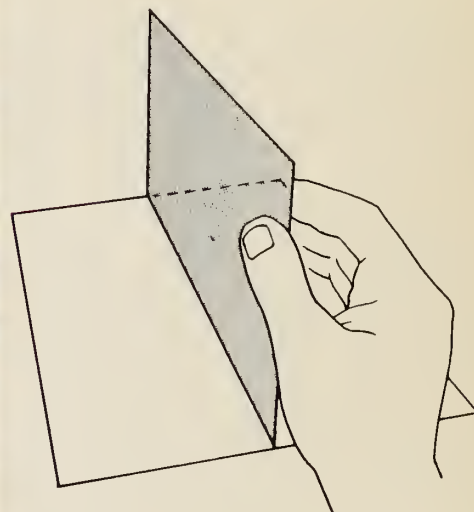




*Low oblique false color photograph taken in August of a cornfield in Gloucester Township, Ontario, illustrating areas of normal growth (magenta) compared with stunted plants and bare soil due to extremely heavy summer rainfall.*



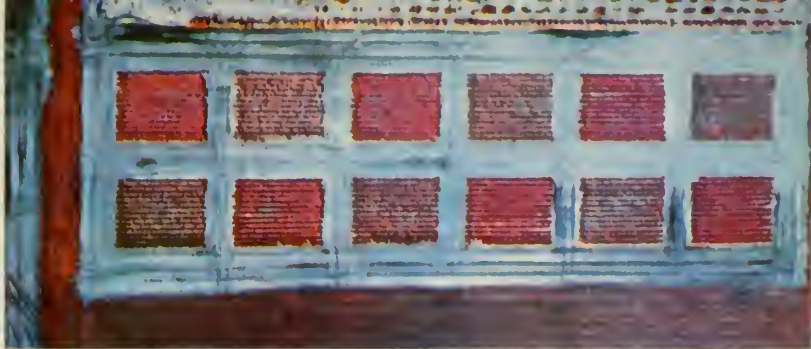
*Ground stereo pair of photographs taken of a cornfield in September. Corn plants in water exhibit stunted growth compared with mature plants on higher, drier ground in the background. This reproduction can be seen in three dimension by placing a card vertically between the stereo pair and viewing each side separately, as shown below.*



*Vertical aerial false color photograph of mature corn in southwestern Ontario. The cyan portions of the rows show sites of aphid infestation while the magenta portions indicate healthy plants.*



*Vertical false color aerial photograph of bean plots taken over the Central Experimental Farm, Ottawa. Healthy plots are exhibited in magenta while the plots infected by bacterial blight appear cyan.*



frared portions of the spectrum increases the possible variations of response patterns.

We see the natural world in three basic colors: blue, green and red. Growing plants appear green because, in broad terms, the green band of the visible spectrum is either reflected or transmitted by leaf tissue. In other words, green light is not absorbed for the photosynthetic process. Neither is near-infrared radiation absorbed and its high reflective properties can be utilized to identify plant type and condition. The latter depends on many variables: leaf and plant size, texture, vigor, moisture content, nutritional level and soil condition.

Plants may exhibit visible symptoms under advanced stress and therefore these symptoms may be recorded by conventional color photography, a procedure which might be called a three-band or multi-emulsion sensor. However, some conditions exist in crops which are not visible by normal means but may be detected by using wavelengths beyond the visible spectrum; that is, in the "photographic infrared".

The value of photographic infrared (so-called false color photography) for aerial sampling of crop condition, forests and the characteristics of some soils lies in its ability to reproduce as a "color" those wavelengths which are invisible to the eye. Infrared-sensitive color film is also a multi-emulsion sensor which records green and red from the visible portion of the spectrum, in addition to near-infrared. Interestingly, or confusingly, the three layers that compose the film are the same three colors required for conventional photography—red, green and blue. A blue image is produced from those portions of the scene which reflect green light; a green image results from red reflection; and a red image is indicative of reflected infrared.

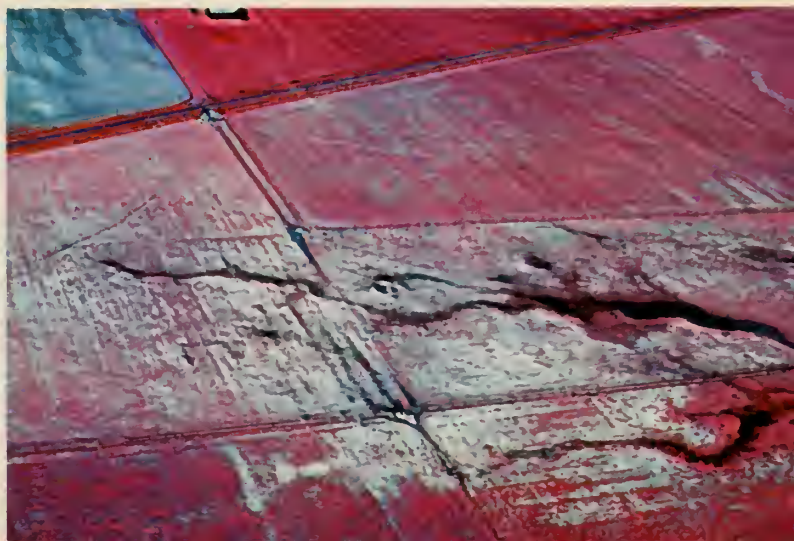
The reason green plants are not reproduced as a blue color is related to the fact that the level of sensitivity in the infrared response layer is about five times that of the green response layer and, as a result, the green record is overwhelmed. Soil may be seen as bluish-green depending on its surface moisture, sun angle and angle of view. Water, on the other hand, is usually shown as black because it is an efficient absorber of infrared radiation. It is the variation in tone and color in the red or magenta image which is assessed to determine plant vigor. It was thought at one time that the variation of infrared reflection from plants was due to chlorophyll break-

down in the mesophyll tissue prior to the appearance of visible symptoms of stress or infection; now however, studies indicate the behavior of infrared reflection or absorption is dependent on the optical characteristics of the air/water interface within the cells. The fact that infrared reflection from plants is reproduced as red is not really important as the process is only a method of photographic image enhancement.

It has been demonstrated that density levels in photographs can be related to known infection levels of disease in experimental plots. These relationships can be utilized in the development of crop loss assessment methodology for determining disease levels necessary for yield predictions. As well, work is being done to separate optically the color response layers contained in false color film to determine which layer provides the most information recorded for a particular disease or crop condition. Enhancement techniques then allow analysis by computer.

Currently, false color photography is being tested on a variety of crops and conditions to develop methods for the early detection of plant stress and related problems. During the past two years, experiments at Ottawa have shown that bacterial blight of field beans can cause up to 40 percent yield loss. This is an important consideration for bean growers who annually produce an \$8-million crop in the relatively small growing area of southwestern Ontario. False color photography can be used to develop methodology, as early symptoms of the disease can be detected and its progress monitored throughout the

*Drainage pattern on clayey soil west of Ottawa, Ontario showing sparse growth (reddish areas), standing water (black) and patches of wet soil with dry soil surface (light tones).*





growing season. By photographing infected plots at weekly intervals from disease onset through to senescence, disease progress curves can be established by density measurements and related to crop yield loss.

False color photography can also be used to detect insect damage. In 1970, aerial infrared photography detected aphid infestation in corn. It was determined that infestation levels in the various fields photographed ranged from 6.68 to 64.45 percent. It was shown that high infestation levels interfere with pollination and result in lower yields. On false color film, healthy corn is depicted as magenta (deep purplish-red) and the aphid-infested areas as cyan (blue). In this situation, aphids attack the corn tassels and form a honey-dew which sooty mold fungi then feed on; the color produced is due to the lack of infrared reflectance from the fungi.

In the winter of 1971-72, extensive winterkill followed by abnormal rainfall took place in the Ottawa Valley and aerial photography was used to help determine the extent of the problem. In a false color photograph, magenta is indicative of plant growth whereas cyan records areas of winterkill. Actual economic losses can be assessed by determining the void areas and the value of the particular crop that is involved.

Actual damage from excess rain in tall crops, such as corn, or from winterkill is difficult to assess on the ground but aerial infrared photography can be used to indicate the extent of the damage.

Remote sensing techniques, particularly infrared aerial photography, have and will continue to provide useful information toward the solving of practical agricultural problems. ■

## WHAT'S UP IN THE AIR FOR REMOTE SENSING?

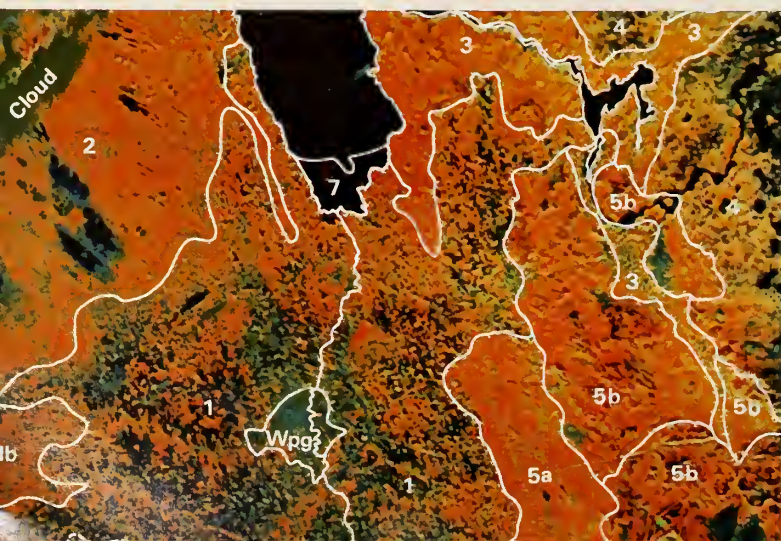
More and more, satellites are being used to collect data which scientists hope will provide new scope for their research into the earth's resources. There is the possibility that remote imagery can add dimension to information that is gathered on the ground.

At the present time, there is only one satellite in operation that has been specially designed for remote study of the earth. Launched by the National Aeronautics and Space Administration (NASA) on July 23, 1972, the ERTS-1 is orbiting the earth at an altitude of 508 statute miles and, by the use of radio transmission of imagery, repeats the coverage of any particular area of the earth's surface every 18 days. Images are transmitted in four radiation bands—red,

Interpretation by Dr. A.R. Mack, CDA Soil Research Institute, Ottawa.

green and two reflective infrared (non thermal). Each image includes an area 110 miles square with a scale of 1:1,000,000.

An agreement has been made between the Canadian Government and NASA for the exchange of data received over North America. A receiving station, funded by the Federal Government, has been established at Prince Albert, Saskatchewan to receive this data from the Earth Resource Technology Satellite (ERTS). All useful imagery received over Canada is processed at the Canada Centre for Remote Sensing in Ottawa and is distributed to researchers for interpretation and application to resource study work. At present, Canada is the only country outside the United States that has facilities to receive its own signal from the ERTS-1 satellite.



*Electronic color enhancement from ERTS-1 imagery of the agricultural areas of Manitoba showing vegetative patterns transmitted on July 30, 1972. The numbered areas can be identified as follows: (land capabilities bracketed)*

- 1 Red River Plain (Central Section) (2,3)
  - a) lacustrine deposits; b) alluvial sediments
- 2 Interlake Till Plain (4,5,6,7)
- 3 Lake Terrace Section (6,0,3)
- 4 Precambrian Drift Plain (7,0)
- 5 South-Eastern Lake Terrace Section
  - a) complex landforms of glacial deposits and lacustrine sediments, (4,5,6,0);
  - b) variety of superficial deposits of sediments, (4,0,6)
- 6 Assiniboine Delta Deposits (2,3,4,5)
- 7 Lake Winnipeg Delta (7,6)



# NITRATE-NITROGEN POLLUTION OF SURFACE AND GROUND WATERS



*Proper design and management of feedlots are essential in the prevention of pollution of surface and ground water.*

En raison du climat actuel au sujet de la pollution, des chercheurs de Lethbridge ont fait des études afin de déterminer si l'azote nitrique provenant de fumier ou d'engrais chimique pollue les eaux de surface et souterraines. Les résultats indiquent qu'ils pourraient être source de pollution s'ils sont appliqués à l'excès ou mal employés, mais, en pratique, on a trouvé que leurs taux de pollution étaient faibles. Le choix de l'emplacement et l'aménagement des parcs d'engraissement, ainsi qu'une bonne gestion contribueront à éviter la pollution causée par le fumier ou les engrais.

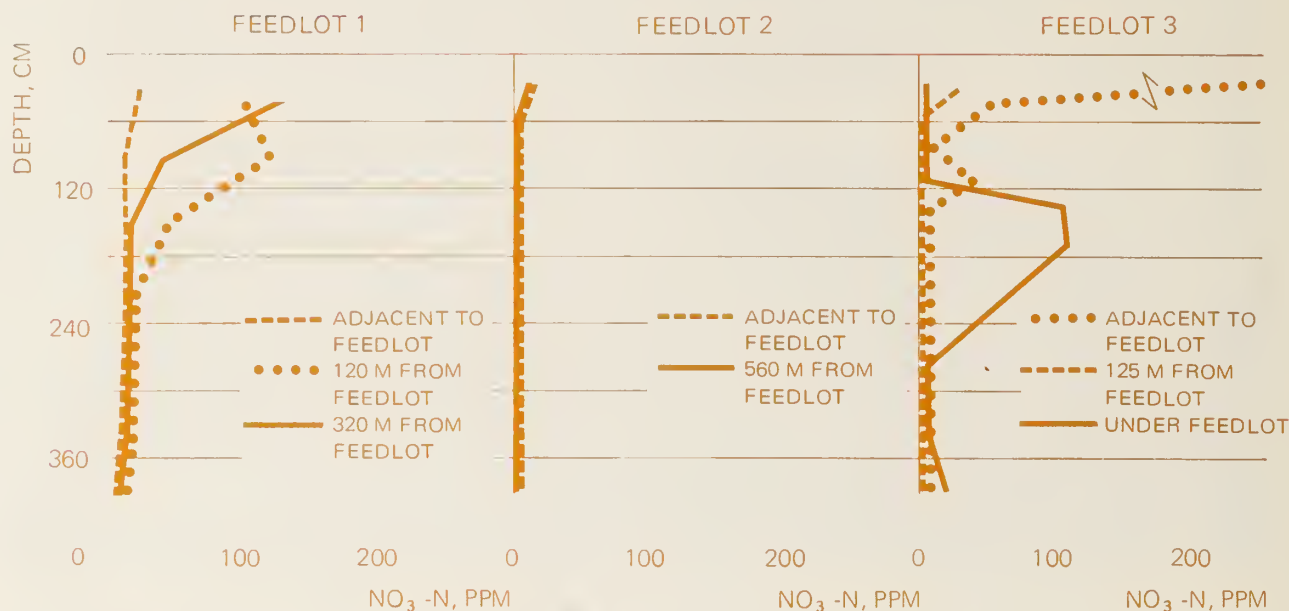
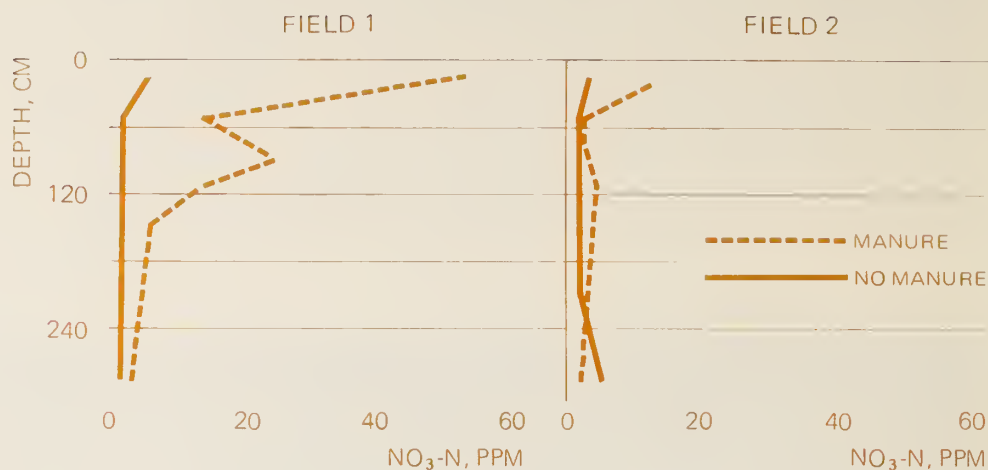
## THERON G. SOMMERFELDT

Is nitrate nitrogen from manure and fertilizer polluting our surface and ground waters? Results of research conducted in the vicinity of Lethbridge, Alberta, indicate that it is not doing so in that area.

Of the plant nutrients in calcareous soils, nitrate nitrogen leaches most readily; the other nutrients are generally fixed and thus are immobile in the soil. An excess of nitrate nitrogen in water is undesirable for it excessively stimulates the growth of plants in our lakes and streams. Water that contains more than 10 parts per million of nitrate nitrogen is considered unsafe for drinking.

Dr. Sommerfeldt is a soil scientist at the CDA Research Station, Lethbridge, Alta.

Graphs showing nitrate-nitrogen content of manured and unmanured soils. Field 1 received 70 tons of manure per hectare annually for 40 years whereas Field 2 received an average annual application of 55 tons of manure and 57 kg of ammonium phosphate per hectare since 1951.



Graphs showing the nitrate-nitrogen content of the soil at and near feedlots.

Manure, when properly applied to the soil, provides plant nutrients and often improves the physical condition of the soil. However, when applied in excess or improperly managed, manure can pollute soil and water. The establishment of large feedlots and the consequent production of vast amounts of manure in a small area has created serious problems of disposal. It has been estimated that 1,000 cattle in a feedlot produce about 30 tons of manure a day.

#### POLLUTION STUDIES

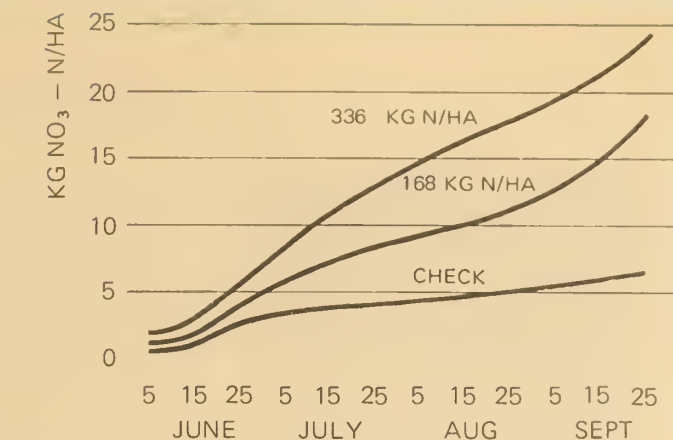
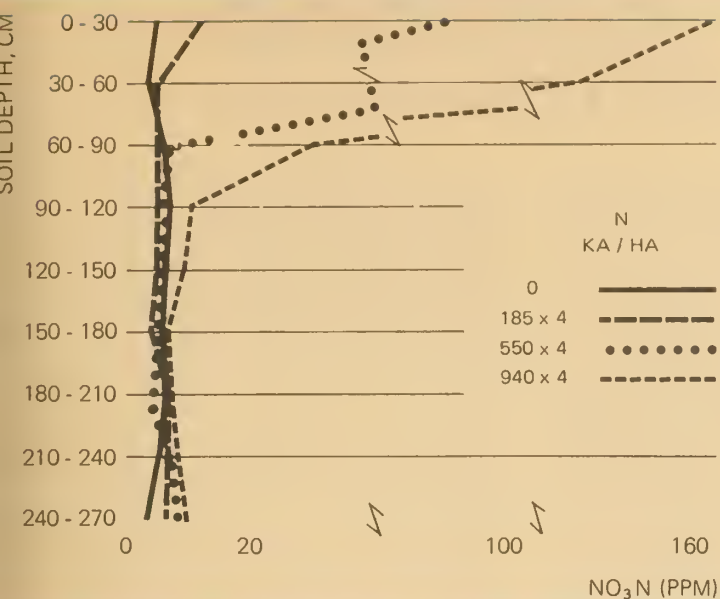
At the CDA Research Station at Lethbridge we are conducting studies to determine whether nitrate nitrogen from manure or from fertilizer applied to

the land is polluting our surface and ground waters.

The nitrate nitrogen content of soil from two widely separated fields of known manuring history was compared with that from adjacent nonirrigated fields, which had never been manured or fertilized. One field had received 70 tons of manure per hectare (30 tons per acre) annually for 40 years. The second field had received an annual average application of 55 tons of manure per hectare (24.5 tons per acre) plus 57 kg of ammonium phosphate per hectare (50 pounds per acre) since 1951.

In both manured fields the nitrate nitrogen was contained primarily in the root zone and had not approached the groundwater depth. Even though the





Graph (Left) showing the nitrate-nitrogen content of soil under non-irrigated grassland after four consecutive annual applications of nitrogen fertilizer.

Graph (Above) showing the nitrate-nitrogen recovered in drain water during 10 weeks after application of fertilizer. The soil had received 74 cm (29.1 in) of water in this period.

soil of the manured fields contained more nitrogen than that of the unmanured fields, the buildup had not reached undesirable proportions. The applied manure had replaced the nitrogen removed from the soil by repeated cropping and had thus ensured a desirable high level of fertility for future cropping.

Soil samples collected at and near three feedlots also were analyzed for nitrate nitrogen. Two of the feedlots had been in operation for more than 40 years.

### LEACHING LOSSES MINIMAL

The nitrate nitrogen was contained primarily in the surface 150 cm (59 inches) of soil, except under one feedlot, which was situated in a depression. Only under this third feedlot was there any indication that the nitrate nitrogen had approached the groundwater depth. The results of analyses of groundwater sampled throughout the year from observation wells near the feedlots indicate that the groundwater was not being polluted by nitrate nitrogen from the feedlot manure.

In studies designed to determine the effect of heavy applications of fertilizer, 940 kg of nitrogen per hectare (840 pounds per acre) was applied annually for four consecutive years to nonirrigated grassland. Analyses showed that all the nitrate nitrogen was retained in the upper 120 cm (47.2 inches) of soil. In another field, 336 kg of nitrogen per hectare (300 pounds per acre) was applied to an irrigated sandy soil underlain by subsurface drains and sup-

porting grass pasture. This soil had received 74 cm (29.1 inches) of water over a 10-week period but less than 25 kg of nitrate nitrogen per hectare (22.3 lb/acre) was lost in the drainage water. However, more than 19 percent of the 336 kg of nitrogen per hectare that had been applied to a loam soil growing an alfalfa-bromegrass mixture was recovered in the drainage water after two irrigations of 12 cm (4.7 inches) each, two weeks apart. More than 17 percent was recovered at the first irrigation. Seemingly, the kind of crop affects the movement of nitrate nitrogen in the soil. Alfalfa fixes nitrogen and has long tap roots to provide internal drainage ways. Grass, on the other hand, does not fix nitrogen and has a shallow fibrous root system. The rates of application of nitrogen in these studies far exceed those normally used by farm operators in the area.

Because of the level topography, limited precipitation, high losses of water through evaporation, and high water-holding capacity of most of our soils, loss of nitrate nitrogen through leaching and runoff is small. Analyses of surface waters near feedlots and of two streams in agricultural areas indicate that pollution of these waters from manure and fertilizer is minimal.

Even though evidence of nitrate-nitrogen pollution of our waters was not found, nitrate nitrogen from manure and fertilizer is a potential polluter. However, judicious placement of feedlots and good management in the disposal and use of manure and fertilizer on the farm will do much toward avoiding pollution. ■

# ECHOES

## FROM THE FIELD AND LAB



South Saskatchewan plant breeders, D.S. McBean and T.F. Townley-Smith, make crosses between plants in a growth cabinet at the CDA Research Station at Swift Current, Sask.

### ESCALATION IN "FEED" WHEAT PRODUCTION

Although the diets of advancing nations evolve gradually from a cereal to a meat basis, the demand for feed grains increases with the need for feedstuffs for cattle, hogs and poultry. Higher yielding wheat varieties such as Pitic and Glenlea are competing favorably with oats and barley. E. A. Hurd of the CDA Research Station at Swift Current, Sask. feels that interest in Utility wheats is on the upswing in 1973 even in the face of expected high prices and strong demand for bread wheats.

The new Utility grades have impressed livestock feeders as well as egg and broiler producers. There is also a potential use for flour for special purposes such as crumb, breeding or pastry flour both in pure form and in mixtures with high protein bread flour for baking bread.

Due to the economic factors involved, rapid market expansion is possible in various parts of the world for Utility wheats for either food or feed.

### TIMOTHY PLUS INTERNATIONAL

MM Miles Bullen et J. C. St Pierre de la Station de recherche de Ste Foy viennent de lancer le premier numéro de TIMOTHY PLUS, feuillet d'information sur le genre *phleum*.

TIMOTHY PLUS a pour but de mettre en contact les chercheurs du monde entier qui s'occupent du mil ou de la fléole des prés et des autres espèces de *phleum* et bien entendu *Phleum pratense* L.

Nous voulons intéresser les scientifiques impliqués dans toutes les sphères de la recherche sur *phleum*, de sa biologie jusqu'à sa distribution géographique.

TIMOTHY PLUS est un organe d'échange sous forme de feuillet qui permettra à chacun de faire connaître aux autres le sujet de sa recherche, ses succès ou ses échecs (ces derniers sont tout aussi intéressants que les premiers), ainsi que les résultats obtenus. On sait que les travaux d'amélioration génétique apportés à *phleum pratense* L. au cours des 25 dernières années ont été très faibles. Par contre de grands succès ont été accomplis pour le maïs, le blé, la luzerne, le riz etc., dès que les chercheurs ont fait équipe et ont commencé à travailler dans le même sens.

Vu l'importance de la fléole dans l'agriculture herbagère des pays à climat tempéré froid, nous voulons susciter l'intérêt des chercheurs et lancer le même mouvement qui a mené à la réussite pour les autres espèces importantes.

Pour hâter la parution, chaque auteur contribuant au feuillet, sera son propre éditeur et sa contribution sera reproduite par offset. Le feuillet acceptera les contributions en français et en anglais.

Dès le premier numéro, nous avons reçu 65 réponses affirmatives de chercheurs intéressés à recevoir les prochains. Ces chercheurs nous ont d'autre part proposés de faire parvenir TIMOTHY PLUS à 95 autres personnes susceptibles de participer à cette action.

Bien que les réponses nous viennent en majorité du Canada et des États-Unis, la Finlande, la Grande-Bretagne, et le Japon sont bien représentés. L'Australie, l'Argentine, la Suède, la Suisse, la Norvège, la Nouvelle-Zélande, l'Irlande, l'Italie et la Pologne ont aussi manifesté leur intérêt. Comme nous pouvons l'escompter, une distribution d'environ 100 exemplaires de TIMOTHY PLUS serait fort souhaitable pour faire parvenir au plus tôt toute nouvelle importante traitant de la fléole des prés.

### FORAGE CROPS FOR IRRIGATED PASTURES

With more than 100,000 acres of irrigated pasture in Alberta, those involved in the cattle industry foresee irrigated pastures playing an important role in increasing beef production in western Canada.

Dr. D. B. Wilson, pasture specialist at the CDA Research Station, Lethbridge, Alta. has been assessing various forages crops for use as irrigated pastures, considering in particular their total annual forage production, length of life of the pasture, ease of management and average daily gain of the livestock.

Of all the forages tested, orchard grass proved to be superior where it was adapted and proper management was applied. When well irrigated and heavily fertilized, it can

carry three yearling cattle per acre for 110 days and produce half a ton of hay as well. Total beef production per acre of orchard-grass has been about 700 pounds.

High production of grass pastures usually requires fertilization with 200 pounds of nitrogen each season and frequent irrigation. Some mowing is needed to avoid waste of forage and to keep the grass in vegetative production.

### CLAWING APHIDS AFFECT TOBACCO CROP

Scientists at the CDA Research Station, Fredericton, N.B. have shown that aphids inoculate plants not only by their mouthparts but also by their claws. By simulating natural conditions of aphid infestation on tobacco plants, it has been found that these parasitic vectors are responsible for the spread of tobacco mosaic virus (TMV). In addition, although overlooked for many years, it was found that aphids inoculate plants as a result of clawing more often than by using their mouthparts.

### FLÉTRISSION BACTÉRIENNE DE LA POMME DE TERRE

M. Henri Gagnéux de la Ferme expérimentale de la Pocatière a eu l'honneur d'être invité à prononcer une causerie illustrée sur la lutte contre la flétrissure bactérienne à Omaha, Nebraska, É.-U. Les membres de la section de certification de la *Potato Association of America* ont apprécié ses travaux. M. Gagnéux a esquissé les résultats encourageants obtenus au Québec pour lutter contre cette maladie de la pomme de terre. Soulignons qu'elle cause encore le rejet de plusieurs champs inspectés en Amérique du Nord en vue de la certification.

### EFFECTIVE CARROT RUST FLY CONTROL

Dr. A. B. Stevenson of the CDA Research Station, Vineland, Ont. advises that the systemic insecticide, carbofuran, registered last year, will provide protection against the carrot rust fly throughout its first generation. Used as a granular formulation called Furadan 10G, the insecticide is applied with the seed and eliminates the need for growers to spray for rust fly control until the second generation appears about the end of July.

The insecticide appears to be useful in the control of other insects that attack the carrot crop. It looks promising in the control of the aster leafhopper, the insect vector for the yellow disease in carrots, as well as the carrot weevil, an increasingly troublesome pest. Further tests will have to be made before specific recommendations can be formulated.

Carbofuran is a powerful insecticide and should be handled with care and respect, as, indeed, all pesticides should.



# ECHOS

## DES LABOS ET D'AILLEURS

### **WARNING: DON'T HOARD OLD STOCKS OF PESTICIDES**

Experience has convinced researchers at the CDA Research Station, Morden, Man. that organic agricultural chemicals should not be stored over long periods in open containers. Severe injury resulted on sunflowers treated with toxaphene which had been stored at least five years in a partially emptied container. Although the injury resembled that resulting from 2,4-D or MCPA absorption, further testing in the field and in the laboratory, using various crops, revealed that the damage was in fact due to the toxaphene used from storage.

As a result of this experience, Dr. W. O. Chubb at the Morden Station advises strongly that pesticides not be stored for extended periods after their container has been opened. Reliable results can only be insured by using a freshly opened product.

### **ENGINEERING FOR INTENSIVE HOUSING OF LIVESTOCK**

This new publication will be useful for livestock producers as more and more cattlemen are raising their livestock under intensive management and many controlled-environment systems are being built. In addition, pollution control regulations are forcing changes in the design of livestock systems. Research is revealing that it is important to provide the proper environment in order to maintain efficient production levels.

The 22-page publication outlines important principles in the control of animal environment and the disposal of animal wastes and would be useful to either the cattleman considering a new housing system or one wishing to expand his present facilities.

A copy of the publication (No. 1503) may be obtained without charge from the Information Division, Canada Department of Agriculture, Ottawa K1A 0C7.

### **LACTATING COWS REQUIRE SULFUR**

Although the role of sulfur in ruminant digestion has been known for some time, its importance as an essential component of ruminant diets has been recognized only recently.

Sulfur is an important constituent of all animal tissues with much of it in the form of the two amino acids, methionine and cysteine, although many other biochemical entities are involved.

Although there is no essential requirement for inorganic sulfur, ruminants consuming diets containing high levels of non-protein nitrogen need inorganic sulfur for protein synthesis.

Experimental tests carried out by Réjean Bouchard at the CDA Research Station, Lennoxville, Que. concluded that the dietary sulfur level should be maintained within the

0.12-0.26 percent range in order to provide a positive sulfur balance and, at the same time, avoid the problem of overloading the urinary secretion system with sulfur.

### **URÉE POUR BOVIN DE BOUCHERIE**

L'urée est utilisée couramment dans l'alimentation du bovin comme source azotée pouvant être convertie en protéine microbienne. Cependant, certains rapports scientifiques montrent que l'urée, à des taux équivalents, peut promouvoir les gains et parfois n'en rien faire. Il y a certes une question de digestibilité de la ration mais il faut aussi considérer la quantité totale d'azote disponible pour la fermentation microbienne. Ainsi, le tourteau de soja de 44 pourcent protéine peut vous procurer relativement plus d'azote fermentable que le maïs grain de 8 pourcent de protéine si l'activité microbienne est fonction de la quantité d'aliment ingéré.

Une expérience complétée récemment nous montra que l'addition de 1.5 pourcent d'urée à une ration d'avoine et orge n'avait eu aucun effet bénéfique sur les performances de bovin de boucherie de 500 livres. Cependant, l'urée nous apporta des résultats 20 pourcent supérieurs lorsqu'elle était ajoutée à une ration d'avoine et maïs. Dans les deux cas, l'addition de tourteau de soja fut bénéfique. Les taux de gain étaient égaux entre les deux rations de base ou celle dont nous avons ajouté du soja. C'est donc dire qu'il y avait une forte interaction entre la source alimentaire et l'urée.

Il est primordial de considérer la source alimentaire lorsque nous voulons servir de l'urée au bovin de boucherie. Un système est présentement à l'étude aux États-Unis pour déterminer la valeur de chaque ingrédient de la ration qui nous permettra éventuellement de calculer la quantité précise d'urée souhaitable dans la ration. Plusieurs facteurs comme la teneur en énergie, la digestibilité de la protéine, le potentiel synthétique du rumen pourront affecter l'utilisation de l'urée pour le bovin. Il nous reste à mettre toutes ces variables en une équation pour faire face aux multiples rations pouvant être servies au bovin, car l'urée est une solution économique au coût élevé de la protéine.

Le bovin laitier possède un système digestif similaire au bovin de boucherie mais ses fins sont différentes. La production du lait est physiologiquement plus efficace que l'engraissement. Il faudra donc considérer ce fait en regard de son effet sur l'absorption de la protéine qui pourra être supérieure chez la vache laitière.

**ROOTING DOUGLAS FIRS** CDA researchers at Sidney, B.C. are trying to find a way to make tree cuttings produce their own roots. The discovery would ensure the propagation of Douglas fir plus trees, superior

trees characterized by their uniform straightness, growth vigor and lack of spiral grain. These qualities are in great demand at present, but the problem arises that these plus trees will not grow true from a seed. Grafting is a possible but there is a problem of incompatibility in the case of Douglas fir.

Director of the CDA Research Station at Sidney, B.C., H. Andison was approached by officials of the forest industry because of the research station's success in rooting woody ornamentals using synthetic auxins which act like plant hormones. Treatments using two auxins, indolebutyric acid and naphthaleneacetic acid, have been used successfully to root the cuttings of woody ornamental plants.

Natural superior clones, scattered throughout the Pacific northwest, provide source material for tree improvement programs. The parent tree's age is a key factor in rooting and cuttings with trees less than 10 years giving best results.



Scientists at the CDA Research Station at Sidney, B.C. are attempting to develop a method of rooting cuttings of Douglas fir plus trees. These superior trees are characterized by uniform shape, straightness, growth vigor and lack of spiral grain.



# NEW WOODY

W. A. CUMMING

Le tilleul à petites feuilles Morden et l'aubépine Snowbird, deux arbustes rustiques mis au point au Manitoba ainsi que la monarde vivace Neepawa seront disponibles dans les pépinières quand les stocks seront suffisants.

To add to the quality of the environment and the aesthetics of man's surroundings, three new ornamental plant introductions from Canada Agriculture Research Stations in Manitoba are being listed by Canadian nurserymen for the first time. Because of their limited availability in 1973, they will not be featured by "Flowers Canada" in promotional advertising. All three are, however, on their supplementary list and will be advertised when stocks are increased. It is a slow process to propagate new cultivars, especially those of woody plants.

*Tilia cordata* 'Morden' was named in 1968 and registered with the Canadian Ornamental Plant Foundation (C.O.P.F.) in 1969, by the Morden Research Station. It is a hardy seedling selection from the widely grown European littleleaf linden, popular as a street tree in areas which have a milder climate. On the Canadian prairies it has been demonstrated that there is a wide variability in hardiness among seedlings of this desirable European species. The Morden littleleaf linden is the first hardy clonal selection of *Tilia cordata* to be named and introduced for the prairies.

W. A. Cumming is head of the Ornamentals and Fruit Crops Section at the CDA Research Station, Morden, Manitoba.

The 30 year old original tree, in the arboretum at the Morden Research Station, is a symmetrical specimen, 30 feet high, with a dense pyramidal to ovoid head. The bark on the main trunk on this older specimen is greyish with many shallow longitudinal ridges. Bark on younger trees and branches is smooth. Leaves are typical of the species, smaller than those of most lindens or basswoods and medium green in color. Small yellowish, fragrant flowers are produced in pendant clusters in mid-summer.

Propagation is best accomplished by budding in late July or early August to seedling rootstocks of the same species. Limited budding trials at Morden, using seedlings of the native American basswood, *Tilia americana*, as rootstocks, have given a good stand of 1 year whips. It will be a few years before we can judge the permanency of this union. A low percentage of softwood cuttings produced roots under intermittent mist, but growth of the rooted cuttings for the first 2 or 3 years is exceedingly slow.

*Crataegus* × *mordenensis* 'Snowbird', named in 1967 and registered with C.O.P.F. in 1969 by the Morden Research Station, is a second generation seedling of the well-known and widely grown Toba hawthorn. Snowbird makes a shapely small tree with a straight trunk or it will grow into an upright larger shrub if left untrimmed. Leaves vary from lobed to almost entire with serrated margins and are glossy, dark green in color. The double flowers are white, occasionally tinged with pink and are borne in medium-sized, flatish racemes. The roundish bright crimson, ½-inch fruit is produced sparingly. It is harder than its seed parent and from its leaf characters there is no doubt of its hybrid origin.



# ORNAMENTALS

The original cross from which Toba hawthorn was derived (*Crataegus oxyacantha* 'Pauls Scarlet' × *C. succulenta*) was made in the greenhouse at the Morden Research Station in 1935. Seed from this original cross produced 200 seedlings of varying types and hardiness. From among them Toba was named and introduced in 1949. Because Toba hawthorn has many taxonomic similarities to its female parent, *C. oxyacantha*, some taxonomists doubted its hybrid origination, but B. K. Boom of Holland officially described it as a new hybrid species *Crataegus* × *modernensis* Boom in 1959—"Nederlandse Dendrologie 4, p. 257."

The advent of 'Snowbird' which has many more intermediate characters should dispel the doubts concerning the interspecific parentage of both cultivars. Extensive studies have been conducted at Morden to find a suitable hardy seedling rootstock on which to propagate these introductions. Seedlings of *C. arnoldiana* and *C. mollis* have proved the most satisfactory. The best method is to bud in late July or early August to seedlings of either of the two above mentioned species. Seedlings of the two Manitoba native species *C. chrysocarpa* and *C. succulenta* have unbranched tap roots and because of this habit are difficult to transplant. They are unsatisfactory when used as rootstocks. Several other hardy hawthorn species have the same fault.

*Monarda* × 'Neepawa' was named at the Brandon Research Station by its developer, Henry H. Marshall, and registered with C.O.P.F. later the same year by the Morden Research Station. It is a third generation seedling from the cross *Monarda didyma* 'Cambridge Scarlet' × *M. fistulosa* var. *menthaefolia*.

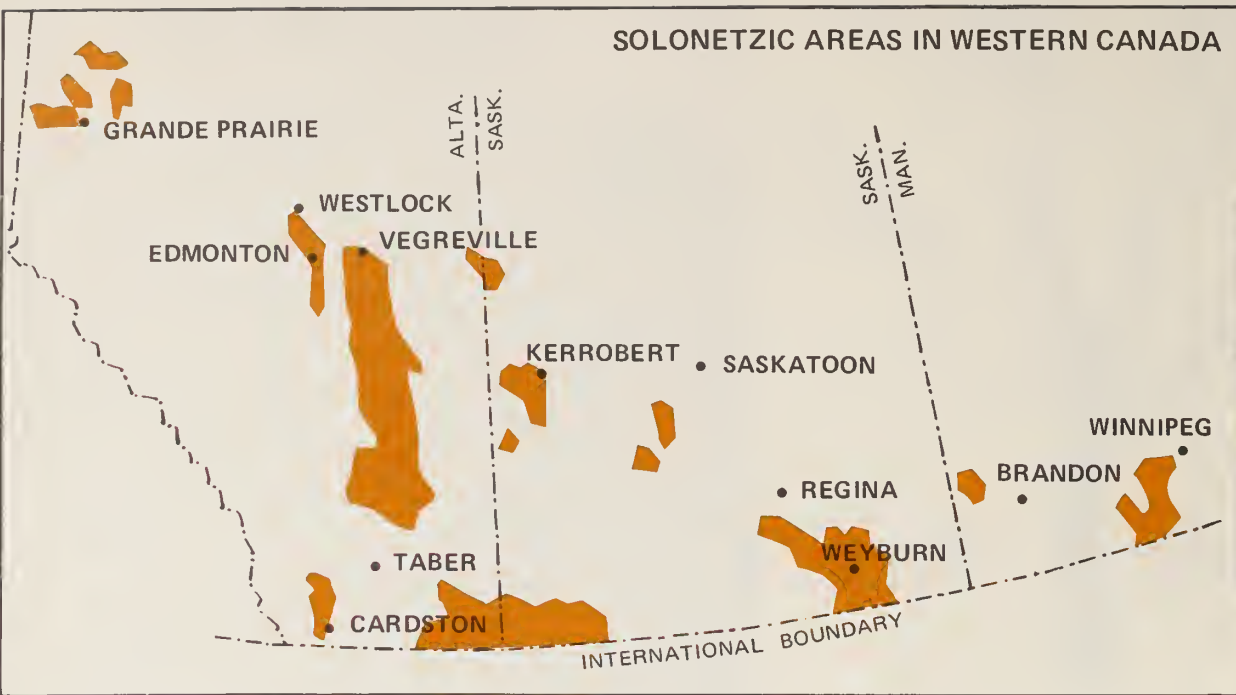


Morden littleleaf linden is the first hardy clonal selection of *Tilia cordata* to be named and introduced for the prairies.

The eastern North American species *M. didyma* has not proven hardy on the Canadian prairies, but Marshall's series of hybrids with the native prairie species *M. fistulosa* has given us a wide range of adaptable *Monarda* cultivars.

Individual plants of Neepawa form clumps, 30 inches broad and 30 inches tall, with scented dark green foliage and numerous dark pink 3½-inch flower heads in mid-summer. The lower lip of the individual florets is broad, giving an appearance of fullness to the flower heads. It is suggested that the plants be cut back to ground level as soon as flowering is past. New growth is quickly regenerated from the crowns and results in a neat mound of attractive green foliage for the rest of the season. It has been demonstrated that this practice will not interfere with the over-wintering of the plants. Neepawa is readily propagated from stolons in the early spring or from cuttings. ■

## SOLONETZIC AREAS IN WESTERN CANADA



## DEEP PLOWING OF

R.R. CAIRNS

Le labour profond, ou défonçage, qui mélange les horizons du sol, améliore les rendements des cultures fourragères et céréalières sur les sols solonchetsiques de l'Alberta. Les recettes à l'acre ont été plus élevées en labour profond qu'en labour superficiel. Un régime approprié de fumure et d'exploitation du sol a permis d'accroître les effets bénéfiques du défonçage sur la production. Les frais de labourage de ces sols sont élevés, mais l'amélioration du sol et de la productivité qui s'ensuit peut durer plusieurs années.

The benefits derived from deep plowing of Solonchets soils are causing Alberta farmers to consider incorporating the technique into their soil management program. Solonchets soils are characterized by a tough, almost impermeable subsoil horizon which restricts water movement and root penetration. Crops grown on these soils generally yield poorly under normal management practices.

Some farmers have already tried deep plowing on an experimental basis and found that crop growth was much improved. However, before deep plowing

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becomes an accepted practice, several questions remain to be answered. "What is the increased value of crop production derived from deep plowing?" and "What is the cost of deep plowing?". Research at the Vegreville station has been directed toward answering these and other questions.

### DEPTH OF PLOWING

Deep plowing can best be described as soil horizon mixing. Instead of inverting a slice of soil, as is the case with ordinary plowing, the top soil (Ap), the hard layer (Bnt) and the limit-salt layer (Csk) are mixed. The technique has a two-fold effect: the tough Bnt horizon is broken up and much-needed calcium carbonate (lime) from the Csk horizon is distributed throughout the soil profile. The success of deep plowing rests on plowing deep enough, generally between 16 and 24 inches, to bring up enough of the lime layer to provide a 1:1:1 mixture of the three soil horizons.

If plowing is too shallow and draws very little lime, the soil will revert to its original hard and unproductive state. Plowing can also be excessively deep. This results in a waste of power and a dilution of the top soil.

Solonchets soils contain a high percent of sodium which destroys the physical properties of the soil. The sodium disperses the finely divided soil particles.





*Equipment has been designed to deep plow the Solonetz soils of western Canada to improve their potential for crop production.*

**EFFECT OF DEEP PLOWING ON THE PRODUCTIVITY VALUE OF SOLONETZ SOILS IN ALBERTA**

Location	Site No	Crop Years	Average \$ / ac / yr.			
			Shallow-plowed		Deep-plowed	
			Check	Fertilized <sup>2</sup>	Check	Fertilized <sup>2</sup>
Chipman		5	22.6	48.2	35.8	52.3
Coronation	1	5	20.2	21.2	23.3	26.7
	2	5	13.2	30.6	20.9	40.6
	3	4	11.9	23.2	16.5	33.2
Fleet		1	14.8	24.4	32.8	36.7
Lamont		3	6.5	19.2	15.6	25.8
Leduc	1	5	12.1	27.8	21.2	36.1
	2	2	40.1	60.4	58.9	65.5
Legal		2	12.2	26.8	32.6	62.8
Vegreville	1	6	14.3	24.6	23.1	29.7
	2	11	28.4		34.6	
Viking		3	8.7	10.5	21.6	23.3

<sup>1</sup>Cereal and hay crops assigned 1970 values; i.e., wheat \$1.25/bu, barley \$0.62/bu, oats \$0.41/bu and hay \$20./ton.

<sup>2</sup>Crop fertilized annually with N at 111 lb/ac, P<sub>2</sub>O<sub>5</sub> at 122 lb/ac and K<sub>2</sub>O at 150 lb/ac.

## SOLONETZ SOILS

In a normal soil these particles are clumped together to form aggregates, thus allowing adequate movement of water and nutrients and penetration of plant roots. Calcium counteracts the detrimental effects of sodium on soil structure.

Laboratory and field studies have shown that calcium also improves the pH regime of the soil. The pH of the surface of Solonetz soils is often low. The nearly neutral pH of the mixed soil horizons is much more favorable to microbial activity and nutrient, particularly nitrogen, availability.

Plowing offers a far more economical way of supplying the needed calcium to these soils than any alternate source of supply presently available. Mixing the top soil and lime-salt horizons of Duagh silt loam caused a ten-fold increase in the growth of wheat in the greenhouse when compared with the growth of wheat in the top soil alone. Plowing such a soil to a depth of 24 inches could draw 12 to 18 tons of gypsum (CaSO<sub>4</sub>) and 20 to 30 tons of calcium carbonate (CaCO<sub>3</sub>) up into the low calcium horizons.

### INCREASED RETURNS

Deep plowing experiments have been conducted on Solonetz soils in Alberta at Chipman, Coronation, Fleet, Lamont, Leduc, Legal, Vegreville and Viking. The increased value of crop production derived from deep plowing alone varied from \$3.00 to \$20.00 per

acre per year. Annual applications of fertilizer led to further increases in production as shown in the table.

Both cereals and forages respond to deep plowing. In the four years, 1966-1969, hay yields of 1875 and 2932 pounds per acre per year were obtained on shallow-plowed and deep-plowed soil, respectively.

Management practices that improve crop production on Solonetz soils include surface drainage, good seedbed preparation, careful seeding and the judicious use of fertilizer.

### COST OF PLOWING

Studies conducted in 1972 in cooperation with the Alberta Department of Agriculture determined the cost of power for plowing to be \$15 to \$20 per acre. The use of a large plow required more power than most farm tractors can generate. Costs varied widely depending on the depth of plowing and the soil type. An operational cost of \$20 per acre for power should be anticipated although farmers using their own equipment could perform the operation for less.

Any such cost must be averaged over several years. The beneficial effect of deep plowing on productivity and soil condition has persisted on the Vegreville site for 13 years and is apparent at several other locations five years after plowing. There is no firm evidence to suggest that these soils are reverting to their original condition. ■

N. E. LOONEY

La couleur rouge est un important facteur dans le choix des pommes chez les consommateurs. Même si la couleur n'est pas nécessairement un indice de la qualité nutritive de la pomme, elle améliore l'apparence et favorise la vente. Les recherches effectuées à Summerland ont donné des lignées de pommes "plus rouges", de même que des produits de vaporisation qui améliorent la couleur et la qualité du fruit et allongent la période de conservation.

Consumers in North America have long considered the amount of red color of red apple varieties to be a reliable measure of eating quality. And indeed, this belief had some basis. Generally speaking, with many of our older red or partially red varieties, selection for red color also selects for higher sugar content, a more favorable sugar-acid ratio, and often better texture. The reason for this color-quality relationship is that all of these factors are related to the exposure of the fruit to sunlight while still on the tree. Sensing these things, generations of brokers, wholesalers, retailers and consumers have perpetuated a tradition of rewarding the red apple with a higher price.

Dr. Looney is a pomologist at the CDA Research Station, Summerland, B.C.

The fact is that the relationship between red color and fruit quality is becoming less meaningful. Two recent developments on the fruit growing scene that contribute to this trend are discussed below. With the advent of intensely colored strains, the relationship between red color and eating quality becomes less credible. Sprays have been introduced that improve color, enhance fruit quality and extend the season of availability.

Both these developments mean that the consumer will have less opportunity to use color as a buying guide to quality.

#### SELECTION OF RED STRAINS

The selection by growers and nurserymen of highly colored strains or sports of many of our red varieties has been a prominent feature of the apple industry over the last two decades. By and large, these selections have been based only on color intensity and overall fruit appearance. The assumption made by the selectors was that the only genetic mutation which had occurred was the one which led to color improvement and that other characteristics such as flavor were unaltered from the parent or standard type. This assumption may or may not have been correct.

Highly colored red strains of Delicious (not to be confused with Golden Delicious which is an unrelated variety) are now being grown around the world almost to the exclusion of the original standard Delicious. These strains develop fruit of uniformly high



*Comparison of Delicious apple (left) with one of the new red strains of this same variety.*



color which has met with wide consumer acceptance. Simply stated, the apple industry is capitalizing on the consumers' belief that high color means high quality.

Why are the red strains redder? There appears to be more than one explanation. Fruit of the red strains often demonstrate a capability for coloring under climatic and weather conditions previously thought to be unsuitable for this purpose. Thus, southern areas of the USA are now growing Delicious with acceptable color (although they are often atypical in shape and not particularly high in eating quality). Since the parent strain of Delicious is known to be incapable of coloring in these warmer growing areas, this explanation involves the physiology of apple fruit coloring. Another explanation involves the distribution of anthocyanin (the red pigment in apples) throughout cells near the fruit surface. In contrast to the older varieties where the pigment is found in only one layer of cells, the highly colored mutants may have pigmentation in several layers. Thus we hear the term double-reds to describe more strains of Delicious.

#### **ORCHARD SPRAYS WHICH IMPROVE COLOR**

In order to grow and sell apples at competitive prices, orchardists have had to rely heavily on various technical advances to keep production costs down. Thus, within the last 25 years, we have seen the introduction and wide-spread acceptance of plant

hormone sprays to control fruit drop prior to and during the harvesting operation. Other materials are used to avoid the costly hand-thinning operation and still others are now being used to regulate harvest period. These latter sprays have also been found to improve fruit color and, fortunately for the consumer, fruit quality.

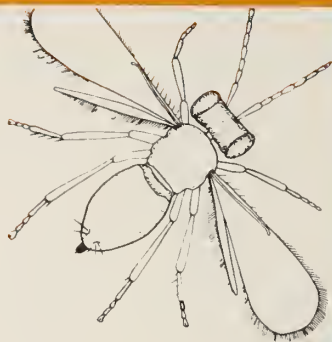
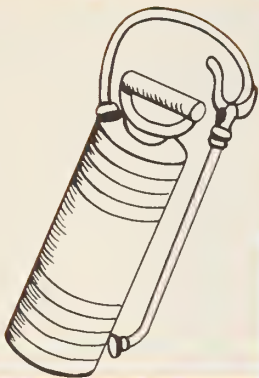
Chemicals which regulate harvest period achieve this by zeroing in on the natural hormone system controlling fruit ripening. The natural apple ripening hormone is ethylene gas which all fruits produce to a greater or lesser extent. When fruits start to ripen they begin producing more ethylene than previously. Such processes as softening and a loss of acidity then become active.

A material used by orchardists to delay the start of ripening is called Alar (Uniroyal Chemicals Ltd., Elmira, Ont.). Alar functions by suppressing, for a time, the amount of ethylene produced by apples. Thus they remain firm and otherwise in a condition suitable for storage and handling when harvested a week or so later than normal. This permits the orchardist to utilize his labor resources more efficiently. Alar-treated apples are of generally superior quality and in addition they often develop better color by remaining on the tree longer during good coloring weather. There is also evidence to indicate that Alar enhances apple color more directly. But whatever the explanation, the net result for the consumer is a redder apple. Happily, since other aspects of quality are also improved, there is no worry that this is just a cosmetic treatment aimed at selling an inferior product.

Drawing on their knowledge about ethylene and its role in natural ripening, scientists have very recently discovered a method of advancing by several weeks the ripening process in apples. This technique, while not yet in widespread use, couples a dramatic increase in red color on some cultivars such as McIntosh with the development of a tree-ripened flavor and texture within two weeks of treatment. The opportunity to market fruit of high quality early in the fall is obviously of great interest to producers. Both they and consumers know that the earliest fruit, while commanding a good price has traditionally been of poorer quality than is evident later in the season. This need no longer be the case.

The fruit industry will continue to seek ways to improve the color of their apples. They do this because consumers demand it. The techniques used should also be of interest to consumers. The selections of new color strains, while improving product attractiveness, have not improved other aspects of fruit quality. On the other hand, recently introduced management practices aimed at advancing or delaying harvest have resulted, incidentally, in improved color coupled with improvements in fruit quality. The consumer gains by having better quality fruit available over a longer season. ■





## INTEGRATED CONTROL OF GREENHOUSE PESTS

R. J. McCLANAHAN

Le coût de la répression des aleurodes des serres a été réduit grâce à la mise au point d'un programme de lutte intégrée qui combine l'action de parasites élevés artificiellement et de produits chimiques.

Integrated control is the combined use of natural control agents and chemicals to regulate pest numbers. Integrated control programs are ideal for greenhouse crops because they are enclosed and have only a few major insect and disease problems.

A project was undertaken at the Harrow Research Station to find a means of controlling the greenhouse whitefly and two-spotted spider mite on crops of cucumbers and tomatoes in the greenhouse. Chemicals were known to give some measure of control but they were dangerous to apply in the greenhouse and had to be applied continually through the season. The integrated control plan consisted of the use of a

Dr. McClanahan is an entomologist at the CDA Research Station, Harrow, Ont.

whitefly parasite and a selective chemical which acts in several ways.

The parasite is a small wasp with the scientific name *Encarsia formosa*. It has been known for many years but was not used extensively after 1940 because it was quite susceptible to most chemicals including DDT. Although it is in the wasp order of insects, *Encarsia formosa* is harmless to humans and to plants. Its only food is the greenhouse whitefly. Adult parasites will suck the juice from small whitefly larvae and lay their eggs inside larger whitefly larvae and pupae. As the young parasite develops the whitefly darkens, so parasitized whiteflies are quite distinct from normal ones.

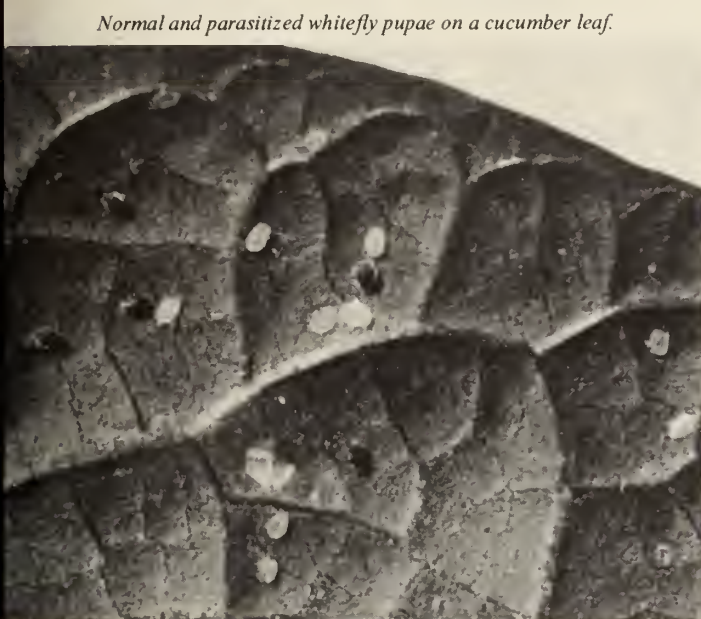
### INTEGRATED CONTROL

Parasites working by themselves can control whiteflies under certain conditions. Control is further effected by a chemical which kills whitefly eggs and some adults but does not affect the parasite. Such a selective chemical is quinomethionate, sold under the trade name Morestan. The suggested program for greenhouse cucumbers is a release of quinomethion-





Whitefly adults on a tomato leaf.



Normal and parasitized whitefly pupae on a cucumber leaf.

ate at two week intervals. This allows the parasite time to build up in numbers while keeping whitefly under control. Powdery mildew of cucumber and two-spotted spider mites are also well controlled by the sprays.

The program works equally well on greenhouse tomatoes but commercial use is not possible until quinomethionate is registered for use on this crop. This is being considered now.

When parasites are established in the greenhouse, the whitefly adults cycle at fairly low population levels. Since whiteflies do not damage the tomato or cucumber fruit, these low levels are not harmful. It is essential that some whiteflies remain so that parasites can persist. In cucumber crops, the integrated control program was sufficient to maintain a good balance of whiteflies and parasites over the six-month period of the crop.

## ADVANTAGES

One obvious advantage of the integrated control schedule is cost. On an area of 10,000 square feet, the comparative cost of material would be:

<i>Integrated Control</i>		<i>Chemical Control</i>	
Parasites	\$10.00	3 fumigations	\$11.71
3 whitefly sprays (quinomethionate)	5.67	3 whitefly sprays (endosulfan)	35.10
1 mildew spray	2.83	4 mildew sprays	11.34
<hr/>		<hr/>	
\$18.50		\$58.15	

There are also savings in labor.

There are other advantages of equal importance. Growers are exposed to a chemical which is only slightly toxic to humans. The bulk of the harvest will not have any contact with insecticides. Several growers have reported better yields since they use less insecticide.

When parasites are widely used in a particular greenhouse area, the program should have an overall impact on the whitefly population. In the past, a considerable number of greenhouse crops were abandoned in the spring because of very heavy whitefly infestations. Large numbers of adults escaped to infest outdoor crops and weeds. With integrated control, whiteflies and parasites will be at low numbers in the spring, and the escaping whiteflies could be subject to natural control by escaping parasites.

## INCREASING USE

Greenhouse growers have been enthusiastic about the integrated control program. Some have even found that the parasites alone were sufficient if they were introduced when whiteflies were just starting. A typical comment was received from Mr. Owen; "... at this time it is very hard to scare up even one whitefly in this greenhouse. In other houses we have considerably more whitefly even though we have been using an insecticide ...".

The demand for parasites is increasing rapidly. The Ontario Greenhouse Vegetable Producers' Marketing Board has set up a rearing facility to provide for members' needs, and other enterprises are being organized for the commercial production of *Encarsia formosa*. Over the past three years the estimated distribution has been as follows:

1970	1971	1972
212,000	947,000	3,557,000

Hopefully whiteflies will become a problem of the past, but growers must be aware that other pests such as leaf miners can become equally serious on tomatoes. ■

La mensuration et la cartographie d'éléments climatiques individuels comportent de nombreux avantages, mais ne satisfont pas entièrement les besoins agricoles. Les agrométéorologistes de l'Institut de recherches sur les végétaux sont parvenus à mettre au point des techniques permettant d'intégrer les effets de plusieurs combinaisons de ces éléments sous des formes ayant une signification pratique pour les agronomes. On a fait grand usage de l'ordinateur dans l'élaboration des techniques d'adaptation de ces données, ainsi que dans la cartographie des résultats obtenus.

Climate affects all phases of agricultural activity. A wide-spread network of stations is maintained to observe and record relevant climatic factors throughout the agricultural areas of Canada. Even the casual observer associates temperature and rainfall with plant growth and development, so it is not surprising that these are the most commonly recorded elements.

Additional measurements such as those of humidity, evaporation, and radiation, requiring more expensive and sophisticated instrumentation are obtained at research establishments where personnel for care and maintenance are more readily available. These factors vary widely throughout the country and mapping has proven to be an efficient tool for illustrating their spacial distribution. Maps of averages of precipitation and of temperatures have become familiar to all.

Other elements are less frequently mapped due to lack of data and widespread use. Their variations frequently have little effect on the senses and useful interpretations required special knowledge.

#### PRACTICAL INTERPRETATION

Complicated interactions of weather elements combine with soils to form the environment in which crops grow. Although measuring and mapping the individual elements are useful, they are obviously not enough. In recent years, agrometeorologists of the Plant Research Institute have had considerable success in developing techniques for integrating the effects of various weather elements into forms that have a practical interpretation for agriculturalists.

Estimates of potential water use by crops, water contents in the rooting zone of crops, irrigation requirements, freeze dates, soil temperatures, aridity indices, plant hardiness and climatic resources for maturing specific crops, have all been generated by using readily available climatic and soils data and established physical and biological principles. Values

Mr. Sly is an meteorologist with the Plant Research Institute, CDA Research Branch, Ottawa.

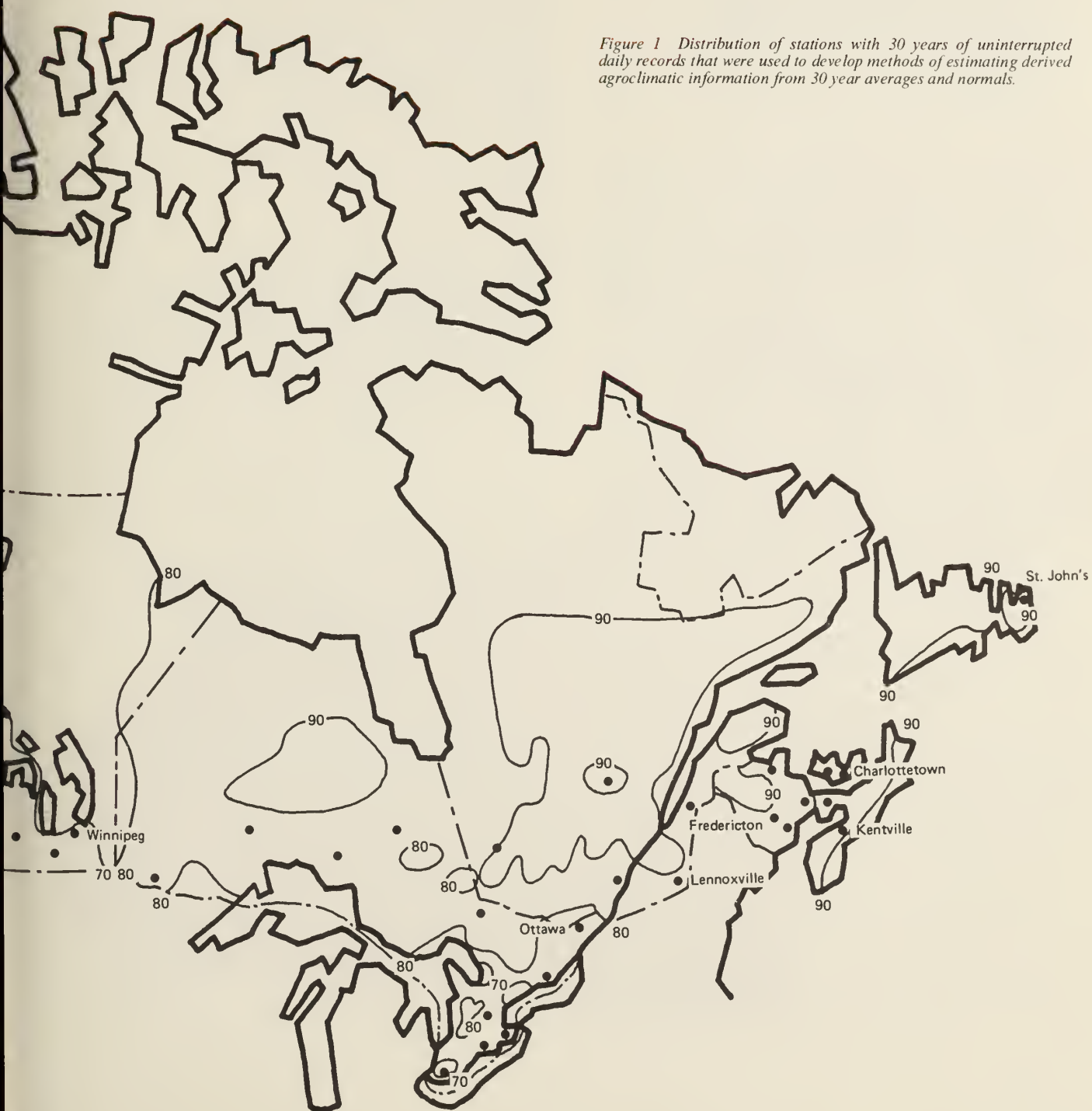
## MAPS OF DERIVED CLIMATIC DATA





# OR AGRICULTURE

*Figure 1 Distribution of stations with 30 years of uninterrupted daily records that were used to develop methods of estimating derived agroclimatic information from 30 year averages and normals.*



# ESTIMATED NORMAL RESOURCE LEVEL

- 1 ASSUMED TEMPERATURE REQUIRED FOR PLANTING (10 C) WOULD NOT BE REACHED
- 2 BARLEY WOULD REACH HEADING STAGE
- 3 BARLEY WOULD REACH SOFT DOUGH STAGE
- 4-7 BARLEY WOULD RIPEN AND THE NUMBER OF DAYS FROM RIPENING TO FIRST FALL FREEZE WOULD BE:
  - 4 LESS THAN 30
  - 5 30 TO 45
  - 6 45 TO 60
  - 7 MORE THAN 60

of the individual elements change at different rates with the passage of time. It may be sunny but cool one day and sunny and much warmer the next. To reflect the full effect of the interaction of these changing values the estimating models must involve as short a time unit as is possible and practical. Usually, climatological data are recorded as amounts (e.g. rainfall) or extremes (e.g. temperatures) for a day, and this is the time unit most frequently used.

To determine long time averages and normals, and the probability of occurrence of critical values, continuous records of at least 30 years are required. Using records in models on a daily basis for a 30 year period becomes a monumental task when many stations and several elements for each station are involved. The introduction of high speed electronic computers has greatly facilitated the development of these models and their application to large volumes of data.



Figure 2 A section of the map showing the photothermal resources of the Canadian Great Plains for maturing barley (courtesy G. D. V. Williams). The original map is the computer output from programs requiring only latitude, longitude, and elevation as observational input (for 1200 locations in this case).



As the ability to manipulate large amounts of data increases, so do the tasks of obtaining and preparing the data for use. For a country as large as Canada, with its diverse topographic, continental and maritime climatic influences, a major problem is to obtain enough data for adequate spacial representation.

## REPORTING STATIONS

Currently, there are about 2500 climatological reporting stations distributed throughout the inhabited areas of the country. A few are located at semi-isolated settlements that have developed due to mining or transportation activities, but most are in areas that have been opened up to agriculture at one time or another. Records are such that for the 30 year period 1931-60 reliable normals have been established for about 700 locations. Although many records begin in the first quarter of the century or earlier, for various reasons there are many discontinuities and less than 10% have essentially uninterrupted continuous daily records for the same 30 year period (This percentage will increase substantially for the 1941-70 period as many of the breaks in the records are in the first 10 years).

Even for this number of stations the great numbers of individual pieces of data involved make it almost prohibitive in costs and manpower to organize all the daily data and put them into the forms required for use in the estimating models. The development of shortcut methods helped overcome these problems.

The technique employed was to select a limited number of stations with the required 30 years of continuous daily data representative of the various agricultural and climatic zones of the country and use their data in the estimating models on a daily basis. Through regression, the results were related to their seasonal normals. By this method it was possible to approximate, (within the constraints of the regressions) the results of using the estimating models for the 700 locations for which normals have been established. Daily data used in the initial analysis came from 35 research establishments and experimental

farms of Agriculture Canada, supplemented by that from 24 reporting stations supported by the Atmospheric Environmental Service (see Figure 1).

## USEFUL RAINFALL

A sample map showing the distribution of the type of derived data resulting from the application of these techniques is provided by Figure 2. The isograms show the percentages of the water provided by rainfall that crops would use during the growing season if plant water stress does not develop. This information is obtained by integrating the pertinent effects of temperature, humidity, wind, rainfall, and the physical characteristics of plants and soils. It is seen that over most of the prairie sections of Saskatchewan and Alberta, rainfall in the growing season supplies less than half of what the plants could use, whereas in most of Eastern Canada it supplies well over 80%. Table 1 shows the percentages for a few localities with aridity conditions familiar to many.

## COMPUTER SUPPORTED

For thematic maps of all Canada, the derived data are plotted on large scale working charts and the isograms are hand-drawn with subjective interpolation. Recent progress in the application of computer mapping techniques, made possible through close cooperation between members of the Soil and Plant Research Institutes, has eliminated much of the tedious hand work required in the preparation of these maps for reproduction. Digitizing and plotting techniques have been combined with standard cartographic and photo-mechanical procedures to produce water-proofs for checking and negatives suitable for plating and printing for full color publication.

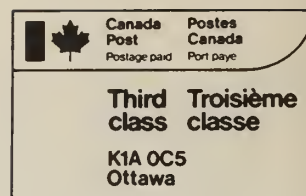
For limited sections of the country where the topography and its changes are relatively uniform, models have been developed to take into account the effects of the physical features. In these cases the raw data are used as input to the computer and the output is the completed map showing the distribution of the derived variable over the area. Figure 3, showing the photothermal resources of the Canadian Great Plains for maturing barley, is an example of the output from such a program.

The above are but two examples from the Agroclicmatic Atlas of Canada—Derived Data, being planned by agrometeorologists in the Plant Research Institute of Agriculture Canada. Among other maps to be included are those illustrating the spacial distribution of seasonal water deficits for various soils on a 50 and 10% probability basis, average number of days when temperatures are higher than certain critical temperatures, mean monthly soil temperatures at various depths, and photothermal resources for maturing wheat and barley. The exploitation of advances in computer capability is opening up new and exciting horizons in the development and mapping of derived agroclimatic data for agriculture. ■

TABLE 1. SELECTED LOCALITIES SHOWING THE RELATIVE ABILITY (SCALE 0-100) OF GROWING SEASON RAINFALL TO MEET DEMANDS IF CROP WATER STRESS IS NOT ALLOWED TO DEVELOP. FIGURES ARE AVERAGES FOR THE 1931-60 PERIOD.

Agassiz, B.C.	85
Kamloops, B.C.	27
Lethbridge, Alta.	50
Swift Current, Sask.	45
Winnipeg, Man.	68
Ottawa, Ont.	78
Lennoxville, Que.	89
Fredericton, N.B.	87
Kentville, N.S.	81
Charlottetown, P.E.I.	84
St. John's, Nfld.	90

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IF UNDELIVERED, RETURN TO SENDER

EN CAS DE NON-LIVRAISON, RETOURNER À L'EXPÉDITEUR

